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Destruction of the Natural Vegetation of North-Central Chile

by Conrad J. Bahre

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Preface

The pervasive degradation of the global environment has loomed large in the news because of its omnipresence, enormous consequences, and the accelerating efficiency with which it is overwhelming the world. Less noticed, however, are the small assaults on the environment in unpublicized local campaigns over the centuries.

These local destructions are not intended or understood by the perpetrators. Indeed they are the only means by which the people can survive. They represent the local inhabitants' desperate choice between destroying the land or dying off themselves. They lack the knowledge to do better, and the resources to act differently if they did realize what they were doing.

An instructive illustration is found in the Province of Coquimbo, Chile, a semiarid mountainous land where the peasants live close to the absolute margin of survival. There, the rural population (the *campesinos*) eke out a bare subsistence from mining, irrigated agriculture, pastoralism, and wild-plant collecting. Like other impoverished people living on poor land in arid regions of the world, the *campesinos* have an absolute and continuing dependency on the sparse wild vegetation. That is their source of food, fiber, medicine, pasture for livestock, fuel, and a variety of other products.

The continuous use of the wild plant resources of Coquimbo has usually been beyond the capacity of the wild lands—an abuse that has degraded them so that the rural population is declining, major economic and social problems have resulted, and far-reaching ecological disequilibria promise an accelerating degradation and collapse. With few exceptions the destruction of the wild lands is the result of land-use patterns that developed in the sixteenth century and have been perpetuated in the conservative culture of the *campesino*.

This book documents and interprets the historical ecological relations between the *campesino* and the wild vegetation of Coquimbo, highlighting the harm to the wild landscape from man's mismanagement. The continued environmental depredations by man assure a bleak future to Coquimbo's rural population unless Chilean planners develop an understanding of the *campesino*'s perception of his natural environment and his relationship to the land. Only then can economic and community-development projects in the Province be made workable.

Man's mismanagement of natural resources in arid and semiarid lands of the world is a problem of growing international concern; indeed this was the subject of a recent United Nations Conference on Desertification, held in Nairobi in September 1977. The United Nations Environment Programme (UNEP) and the Unesco Man and the Biosphere Programme (MAB) are currently sponsoring several initiatives and programs to combat worldwide desertification. Major desertification problems and attempts at reclaiming the desert are challenging the ingenuity of science and government in Israel, Egypt, China, Peru, Sudan,

and a host of other countries. The arid regions of the Southwest of the United States are posing like problems of a magnitude and complexity that are only now becoming recognized.

In Chile, both Unesco and the United Nations Development Programme (UNDP) are working with several national governmental agencies to solve problems of desertification in parts of Coquimbo. These programs, like earlier ones, have not yet come close to solving the social and economic problems plaguing the Province, let alone reversing or even slowing the degradation of the wild plant cover.

The study presented here originated as a doctoral dissertation in geography at the University of California at Riverside. Financial support for field work in Chile from March, 1971, to April, 1972, came from a grant made to Professor H. Homer Aschmann by the National Science Foundation in conjunction with the United States International Biological Program–Origins and Structures of Ecosystems–Mediterranean Scrub Project–Chile-California. Printed and manuscript materials were consulted in a number of libraries and archives in Santiago and La Serena, and several months were spent in various parts of Coquimbo interviewing *campesinos* and studying their land-use practices.

I thank the many persons upon whom I have depended so heavily for support and assistance in this work. Special thanks must be accorded the following in Chile: Ernst Hajek, Juan Gastó, Rafael Baraona, Eugenio Sierra Ràfols, Jochen Kummerow, Pedro Cunill, Mario Peralta, Jorge Iribarren, Julio Montané, Carlos Jiles, René Saa, and the late Carlos Muñoz Pizarro. Thanks must be extended also to Kurt and Nelly Hofmann, in Santiago, who made their home available to me, and to William Weir and Francisco Silva, of the Convenio Chile-California, who made motor vehicles available so that I could complete my field work.

I thank my advisors at the University of California at Riverside, Professors H. Homer Aschmann, Carl L. Hansen, and Sylvia M. Broadbent, for reading and commenting on the original manuscript.

My greatest debts, however, are to the many *campesinos* who took time off from their work to answer questions and act as guides, and to Jill Bertoglio, who aided me in my field work and library research.

1

INTRODUCTION

Desolation and extremely limited environmental possibilities for man are the overwhelming impression of the desert as viewed from the dirt road which threads its way from the Pan-American Highway to Choros Bajos, a small village some 100 kilometers north and west of La Serena, Coquimbo, Chile (see map 1).[1] To the casual observer, man's presence is evidenced only in the tailings and shafts of abandoned mines, deserted goat corrals, and small hovels with *pirca*[2] stone walls. Closer examination of the wild vegetation, however, reveals the impact of numerous human activities.

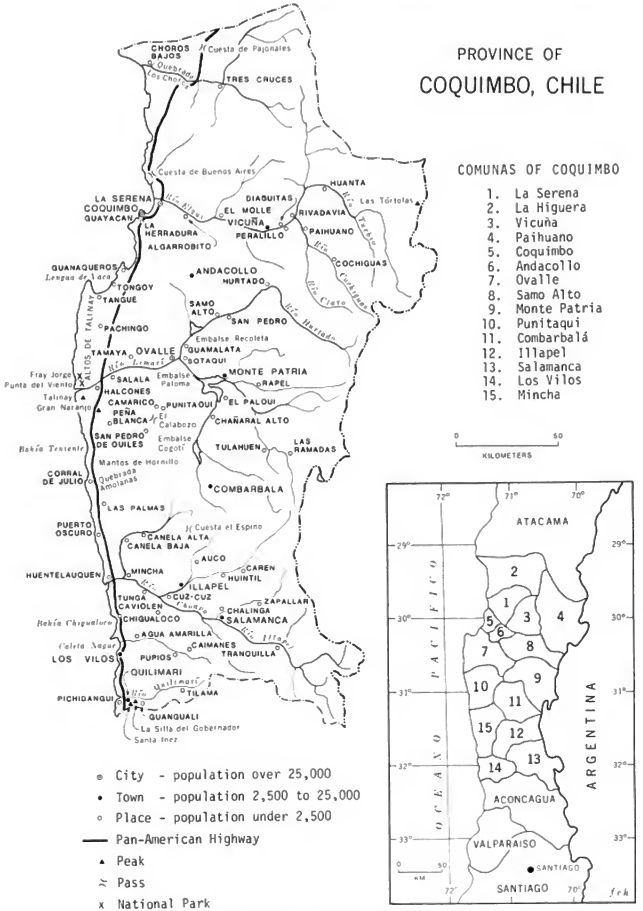
Approaching Choros Bajos, the traveler notices that the terraces and slopes surrounding the village are almost completely devoid of shrubs and cacti; in fact, the density of the shrubby vegetation declines in direct proportion to nearness to the village. Only shrubs which are low in palatability to goats or useless as firewood manage to survive near the town, while the ground is almost completely barren except for a few exotic ephemerals.

Choros Bajos, situated in the bottom of a now-dry arroyo (Quebrada los Choros) only 8 kilometers from the Pacific Ocean, has fewer than 300 inhabitants. The village is a small cluster of adjoining adobe and wattle and daub houses uniformly lining the two east-west roads that pass through town. Choros Bajos is entered via a large dusty plaza surrounding a poorly maintained wooden gazebo. The small church bordering the plaza has no resident priest. To the north, on an alluvial terrace overlooking the town, is the well-kept, roughly built, adobe police station.

From the police station one can see small irrigated garden plots, with olive and other fruit trees, in the river bottom immediately south of town, and in the distance the Pacific Ocean. Also visible are dead olive trees and deserted buildings which mark abandoned olive groves established by a British company some decades ago at Oliverera del Pacifico. From early nightfall to midmorning the village is draped in a heavy fog which moves inland off the Pacific, ameliorating the dryness of the desert while contributing to the drabness of the area. In the past there was a perennial, though sparse, supply of surface water in the river; now, however, crops can be irrigated only by those who have gasoline pumps to draw water from shallow wells dug into the dry river bed.

Choros Bajos is a *comunidad*—a property holding that includes both private and communal land. The *comunidad*, a system of land tenure frequently encountered in the Province

1. Map 1 includes place-names for Coquimbo mentioned in this investigation.
2. A kind of dry-stone wall.



Map 1. Province of Coquimbo, Chile.

of Coquimbo, has its origins in the early colonial period. Rights to private property on a *comunidad,* usually to a small plot for a house and a small piece of irrigated land, and to the use of the communal land, are inherited. Each inhabitant of Choros Bajos claims to know his genealogy and can trace his ancestral rights to land on the *comunidad* back to the original royal concessionaires who held the land in the 1620's.

With a little imagination the traveler can picture Choros Bajos as it must have been centuries ago, for the rudimentary life style and land-use patterns of the people seem to have changed little since the colonial period. The inhabitants are resourceful and conservative, and have developed an enduring dependency on the land and its meager resources. Although small amounts of fish, firewood, fruit, vegetables, goat cheese, and ore are sent to La Serena, the people of Choros Bajos are largely self-sufficient, bartering their services or products among themselves and consuming most of what they produce. Almost every inhabitant of the village learns from childhood the value of each plant and tree in his environment and the uses to which it can be put. The wild vegetation supplies him with food, medicine, building materials, fuel, salable plant products, and pasture for his livestock. These folks, like other *campesinos* in the Province of Coquimbo, utilize the scarce resources of their environment with an ingenuity and efficiency that is little understood or appreciated by the outsider. They utilize the land in much the same manner and with the same degree of self-sufficiency as did their forefathers. It is the *campesino,* in Choros Bajos and the other villages of Coquimbo, and his system of living on the land that have resulted in most of the man-induced changes seen today in the wild vegetation of the Province.

The modern Province of Coquimbo extends from about 29° to 32°15′ south latitude, or from the drainage divide that separates the Río Huasco from the Río Elqui, south to the Río Quilimarí. The Province has a total length of around 360 kilometers and an average width of less than 140 kilometers. It is bounded on the east by Chile's border with Argentina along the crest of the Andes, and on the west by the Pacific Ocean.

The present political boundaries of Coquimbo have a rather complex evolution, and before 1843 Coquimbo included all the northern area of Chile beyond the Río Choapa. The northern boundary of Chile, however, before the War of the Pacific (Chile against Bolivia and Peru, 1879-83), was not clear and was vaguely identified as being in the vast unpopulated area between the Río Copiapó and San Pedro de Atacama (Pederson, 1966, p. 18). The boundaries of the present Province of Coquimbo began to take shape when the Copiapó and Huasco valleys were separated to form the Province of Atacama, in 1843, whereupon the Province of Coquimbo extended from the Río Choapa in the south to the southern drainage divide of the Río Huasco in the north.[3] The northern border of the modern Province of Coquimbo remains the same as the boundary drawn up in 1843, but the southern boundary south of the Río Choapa was not settled upon until 1929, when the Estero de Quilimarí was added to Coquimbo.[4] For descriptive purposes in this investigation, however, Coquimbo refers to the area of the present Province unless specified otherwise.

3. Chile, Dirección de Estadística y Censos, *Sinopsis geográfico-estadístico de la República de Chile* (Santiago, 1933), p. 24.

4. Chile, Dirección de Estadística y Censos, *XIII censo de población* (29 de noviembre de 1960), Ser. B, No. 4, *Provincia de Coquimbo* (Santiago, n.d.), p. 2.

2

PHYSICAL SETTING

TOPOGRAPHY

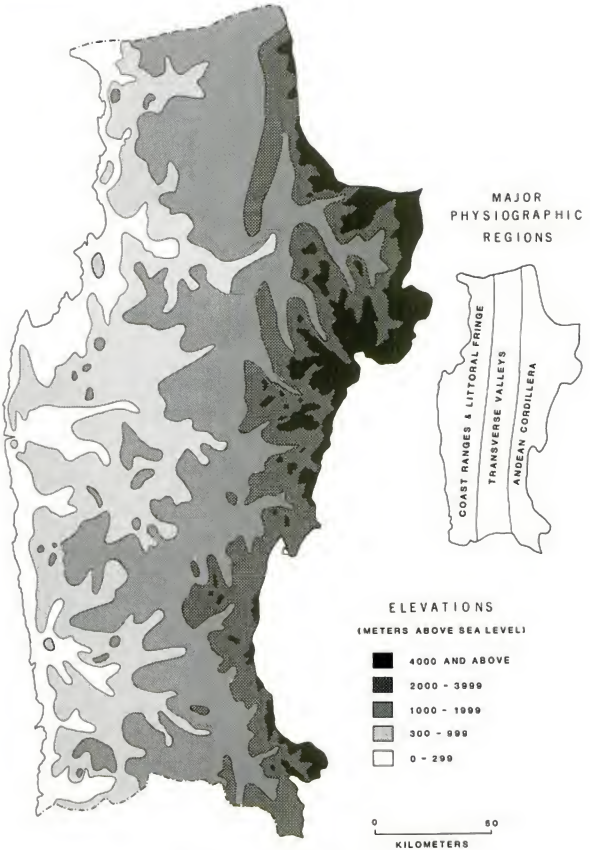
Much of the ecological diversity encountered in the modern Province of Coquimbo can be attributed to the extremely rugged nature of the terrain. Level land is scarce and is restricted largely to marine and fluvial terraces, although fairly extensive alluvial plains are scattered west of Ovalle and along the coast from Tongoy to La Serena.[1] In general, relief is dominated by a pattern of alternating valleys and ridges trending east-west, transverse to the dominant longitudinal structures of Chile–the Cordillera de los Andes on the east, the Cordillera de la Costa on the west, and between the two ranges a series of grabens designated as the Depresión Intermedia. The interfluves of these transverse valleys are formed by spurs of the Andes and the coast ranges which merge in Coquimbo, erasing the Depresión Intermedia that separates the two ranges in northern and central Chile. These interfluves are characteristically of strong relief and are named *montañas medianas* by Paskoff (1970, p. 20).

Physiographically, Coquimbo can be divided into five regions: the Cordillera de los Andes, with numerous peaks over 5000 meters; the *montañas medianas*, with elevations between 1000 and 3000 meters; the large transverse valleys; the Cordillera de la Costa, which is difficult to differentiate from the western section of the *montañas medianas* and whose peaks seldom rise above 1000 meters; and the littoral fringe, a narrow coastal strip of steplike marine terraces, sea cliffs, stacks, headlands, dunes, and beaches (see map 2).

The major trunk streams of the Province–the Elqui, Limarí, and Choapa–flow west from the high Andean cordillera to the Pacific Ocean, cutting deep, broad valleys transverse to the dominant longitudinal structures. These rivers depend on melt water from the large snow storage areas in the high Andes for most of their perennial (though sometimes sparse) supply of water. Except for some dry farming along the coast, crop production in this semiarid to arid Province is confined to irrigated areas in the major river valleys and their tributaries, where the bulk of Coquimbo's 336,000 people live.[2] Not all of the principal streams run transverse to the major structural lines: the Guatulame, a tributary of the Limari, flows from south to north in a longitudinal fault-line valley in the interior of Coquimbo. Historically, the major rivers have provided avenues of access from the Pacific coast to the high passes of

1. Elevations and landform interpretations are taken from 1:50,000 topographic maps prepared by Chile's Instituto Geográfico Militar.

2. Chile, ODEPA, Departamento Programación Grupo Estadística, "Población del país y por provincias a nivel comunal según censos de 1970 y 1960" (Santiago, 1971), p. 3. (Mimeographed.)



Map 2. Topography of Coquimbo.

the Andean cordillera. Most of the cities and towns of Coquimbo are near the mouths of these rivers or at points where the tributaries join. The principal cities seem to have spheres of trade influence corresponding to the watersheds of the streams on which they were established.

The interfluves of the transverse valleys have always been formidable barriers to north-south traffic by land; only after the construction of the longitudinal railway in Coquimbo, in the 1910's, was good overland transport established between Santiago and La Serena (Pederson, 1966, pp. 219 and 224; Walker-Mackenney, 1911, p. 1). Before then, all north-south traffic was restricted to seaways or to cart roads and mule paths. This railway and the old road from Los Vilos to La Serena follow an interior route along valley bottoms and over several ridges, climbing to more than 1500 meters at Cuesta el Espino. The recently completed Pan-American Highway runs along the coast, bypassing the larger towns of Illapel and Ovalle and avoiding high passes except for those at Buenos Aires and Pajonales, north of La Serena. The Pan-American Highway through Coquimbo, however, was not built without construction problems, and large bridges had to span the deep gorges or *quebradas* incised into the littoral fringe by streams flowing at right angles to the coast.

The Andean Orogeny occurred during a period of pronounced tectonic activity near the end of the Miocene or in the beginning of the Pliocene.[3] The uplift of the Andes was accompanied by extensive longitudinal and vertical faulting. That the tectonic processes involved in forming the Andes are still going on is evidenced by present-day seismic activity in Chile. Of course, seismic activity is great because of the considerable changes in relief over short distances in Chile. For example, in Coquimbo there is a difference of over 11,000 meters in relief in less than 250 kilometers along the east-west line from the heights of Cerro de las Tórtolas (6329 meters), in the Andes, to the depth of Fosa de Richard (5000 meters below m.s.l.), offshore from La Serena.

Active volcanoes, so characteristic of Chile's eastern frontier, are presently unknown in the area between Copiapó and Cerro Tupungato east of Santiago. Though no glaciers remain on the western flanks of the high Andes in Coquimbo, Quaternary glacial features are visible in nearly all the high valleys of the cordillera (see plate 1). Few of the Andean passes in the Province lie below 4000 meters except in southern Coquimbo, where the drainage divide that forms the Chilean-Argentine border lies west of the highest peaks, and there are a few passes below 3500 meters.

The Cordillera de la Costa, which is composed of the oldest rocks found in Chile, is generally thought to be the stable western border of the ancient Andean Geosyncline (CORFO, *Geografía económica*, 1966, p. 18). It is composed of complex rocks and includes numerous outcrops, ranging from Pre-Cambrian to Jurassic age. In general, the oldest granites in Coquimbo are in the coast ranges (except for a large body of Paleozoic granites extending from Rivadavia to the headwaters of the Río Claro), and succeedingly younger longitudinal strips of granitoid intrusions are found as one moves eastward.[4] Although some of the coast ranges reach 1000 meters in elevation, most of the ranges bordering directly on the coast are under 800 meters high.

Similarly to the other major rivers in Coquimbo, the Río Elqui flows through a valley that can be divided into three distinctive regions on its way from the high Andes to the Pacific Ocean. In each of these regions are landforms associated with the dominance of one of the following geomorphic processes—glacial, fluvial, and marine. At the head of the Elqui Valley

3. Chile, Corporación de Fomento de la Producción, *Geografía económica de Chile*. First appendix (Santiago, 1966), p. 21. Hereinafter cited as CORFO, *Geografía económica*, 1966. The one-volume revised edition of 1967 is cited as CORFO, *Geografía económica*, 1967.

4. Chile, Instituto de Investigaciones Geológicas, *Mapa geológico de Chile* (Santiago, 1968).

are found well-developed cirques, troughs, moraines, and other features associated with mountain glaciation (Brüggen, 1950, p. 214). The middle course of the Elqui includes alluvial fans, colluvium, landslides, and four major fluvial terraces (Paskoff, 1970, pp. 160-184). The mouth and lower course of the river were inundated by the sea during the Pliocene and early Quaternary and exhibit a number of marine landforms.

Bordering the coast from Lengua de Vaca to Bahía Teniente are a series of recently uplifted horsts, the Altos de Talinay, rising to elevations surpassing 800 meters. According to Paskoff (1970, pp. 256-264), these horsts were uplifted at the end of the Pliocene or in the Pleistocene. The terraces south of the Altos de Talinay can be divided into two sections. The first section, between Bahía Teniente and Bahía Chigualoco, exhibits one large Quaternary marine platform which dips from an elevation above 300 meters in the north to near sea level in the south, near the Río Choapa (Paskoff, 1970, pp. 269-278). The second section, lying between Bahía Chigualoco and the mouth of the Río Quilimarí near the southern border of the Province, shows almost no evidence of neo-tectonic activity such as in the former section, and three continuous marine terraces can be easily identified (Paskoff, 1970, pp. 279-284).

Both active and fossilized dunes are encountered along Coquimbo's littoral fringe, and in many areas dunes are advancing inland, threatening settlements and in certain places occasionally blocking the Pan-American Highway.

Historically, the dominant economic activity in Coquimbo has been mining, and mining has always received priority in the use of natural resources in the Province. Almost every male in Coquimbo has been connected with mining at some time in his life, and most *campesinos* mine to supplement their meager agricultural incomes.

A cursory inspection of the distribution of the metallogenic provinces of Chile demonstrates that the known metallic mineral deposits in Chile occur in greatest variety in the provinces of Coquimbo and Atacama (Ruiz and Ericksen, 1962, pp. 91-106). Traditionally, the mines of Coquimbo have been among the nation's richest and were some of the first exploited by the Spaniards. Pederson. in his excellent work on mining in the Norte Chico, substantiates the diversity and abundance of mineral deposits in Coquimbo by pointing out that over one-quarter of the total mining claims in Chile for metallic substances in 1954 were registered in Coquimbo, and that those claims were for twelve different types of metallic deposits, the greatest number being for copper, gold, silver, and iron.[5]

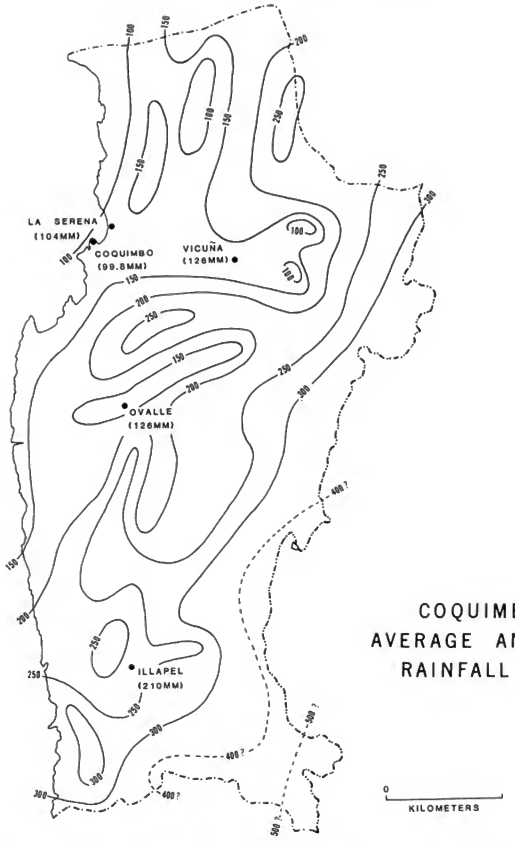
Most of the metallic riches of Coquimbo are genetically associated with granitoid intrusions dating from the Upper Jurassic to the Lower Tertiary. These intrusions are distributed in longitudinal strips that become younger as one moves eastward in the Province. The westernmost strip corresponds to the Upper Jurassic, the intermediate to the Upper Cretaceous, and the easternmost to the Lower Tertiary. The mineralized layers are usually found along contact zones between these intrusive rocks and their overlying host rocks (CORFO, *Geografía económica,* 1967, pp. 85-87).

CLIMATE

The Province of Coquimbo is transitional in climate between one of the earth's driest deserts, the Atacama of northern Chile (with stations reporting an average rainfall of 1 mm or less), and the more humid environs of the mediterranean climate of central Chile. Average annual rainfall is low, varying between less than 75 mm in north coastal Coquimbo, and more than 350 mm in southern portions of the Province (see map 3).[6] Precipitation also

5. Pederson (1966, p. 23) quoting Chile, Servicio Nacional de Estadística y Censos, *Minería, Año 1954* (Santiago, 1959), p. 33.

6. Chile, Oficina Meteorológica, *Pluviometría de Chile,* Part II (Santiago, 1965).



Map 3. Coquimbo–Average annual rainfall. Source: Almeyda Arroyo and Saez Solar (1958).

varies considerably from year to year, with frequent droughts (*sequías*) lasting for several years. The general aridity of Coquimbo is due to the combined effects of the cold waters of the Peru or Humboldt Current and air subsiding out of the eastern portions of the subtropical South Pacific high-pressure cell lying off the coast of the Province. That combination, in association with the orographic barrier of the high Andes, creates regional temperature inversions and stable air (Eidt, 1968). Most of the annual rainfall occurs in the winter months, when the South Pacific anticyclone weakens, enabling a series of mid-latitude and polar cyclonic fronts to bring rain to Coquimbo. Dry summers are the norm, and only in the high Andes are there summer showers, and these are infrequent (*inviernos bolivianos*). Periods of drought along the coast are tempered to some extent by the high incidence of fog and overcast days. Because of the moderating influence of the ocean, Coquimbo is characterized by a certain homogeneity in temperatures. Differences are a function more of altitude and distance from the coast than of latitude.

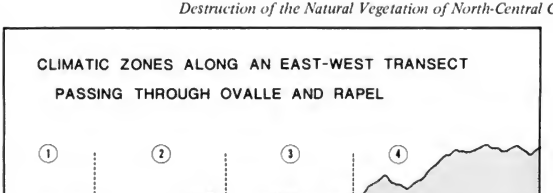
Obviously, an accurate climatic picture of Coquimbo would be contingent on interpretations of long-term meteorological data gathered from weather stations representing the major ecological divisions of the Province, but no such data exist. According to Schneider (1969, pp. 15-19) some of the major deficiencies in meteorological data collecting in Coquimbo include the following:

1. Only three weather stations in Coquimbo have gathered rainfall data for thirty years or more and temperature data for ten years or more. Furthermore, those stations are all in the northwest corner of the Province.
2. The three weather stations which have collected temperature data for ten years or more are not only in the northwest corner of the Province but less than 250 meters above mean sea level.
3. Only fourteen weather stations collect temperature data.
4. There are only two weather stations above 2600 meters, and only one of these collects temperature data.
5. The majority of the weather stations are in the bottoms of the major transverse valleys.

In summary, the climatic data available give little or no reliable long-term information on climatic conditions in the high Andes or in the southern part of Coquimbo. Hence, most information on the climate of the Province is based on rough extrapolation and interpretation. Trustworthy long-term meteorological data will be needed before Chileans can gain a precise knowledge of the ecological or natural regions of Coquimbo, a knowledge which is essential for planning future agriculture and conservation.

The major topographic features of Coquimbo not only play an important role in local climatic conditions but are responsible for important changes in general circulation patterns. The Andean cordillera acts as a barrier, preventing continental influences from reaching Chile. The coast ranges, however, do not constitute an effective barrier to the penetration of marine air, and the broad transverse valleys which trend perpendicular to the coast allow marine influences to invade the high valleys of the Andes almost to the Argentine border.

Rainfall increases not only from north to south but generally from west to east. Map 3 shows the average annual precipitation for selected stations in Coquimbo, while figure 1 indicates annual rainfall along an east-west transect. The Andean cordillera presumably receives the highest amount of rainfall in the Province, a result of orographic uplift of winter fronts passing from west to east, though that presumption is not supported by reliable meteorological data. In fact, some of the pre-cordilleran valleys actually appear to receive



ZONES	PRECIPITATION (MM)		AVERAGE TEMPERATURE (C)		
	AVERAGE ANNUAL	NO. DRY MONTHS	ANNUAL	JULY	JANUARY
1 COASTAL	170-300	8	15	12	18
2 INTERIOR (OVALLE)	125-180	10	16	11.5	28
3 INTERIOR (RAPEL)	200-250	10	18	11	22
4 CORDILLERAN	OVER 250	8	18?	8?	20?

Fig. 1. Climatic zones along an east-west transect passing through Ovalle and Rapel.

less precipitation than coastal stations at the same latitude. The amount of average annual rainfall, however, is not always reflected in the vegetation. For example, many mesothermal hydrophytes and mesophytes in the Province achieve their northernmost extension in the coast ranges because the high incidence of cloudiness and fog gives moisture a greater effectiveness on the coast. Other dissimilarities between rainfall and vegetation may be a function of microclimatic change caused by destruction of the natural vegetation by man.

Over 80 per cent of the average annual rain in Coquimbo falls from May to August, and the remaining amounts in the early fall and late spring (Schneider, 1969, p. 40). The rainiest months are June, July, and August. Snow is rare below 800 meters and absent on the coast. In the high Andes, however, snow is the usual type of precipitation, so the major streams of Coquimbo obtain the bulk of their water supply from snow melt.

The dry season (the summer drought) normally lasts eight to ten months in Coquimbo (Almeyda Arroyo and Saez Solar, 1958, p. 183), although droughts of two to five years are not uncommon. Despite an average annual rainfall of 116.5 mm (CORFO, *Geografía económica*, 1966, p. 37), La Serena had five serious droughts in the period between 1901 to 1960: 1909-1913 (45 mm); 1916-1918 (47 mm); 1935-1937 (75 mm); 1945-1951 (68 mm); and 1953-1956 (67 mm) (Schneider, 1969, p. 60). From 1901 to 1960 there were three extremely wet periods: 1901-1906 (230 mm); 1926-1930 (172 mm); and 1940-1942 (177 mm) (Schneider, 1969, p. 60).

Average annual rainfall is so variable that it is extremely difficult to speak of normal annual rainfall in Coquimbo, let alone predict average yearly rainfall. Gastó (1966, pp. 7 and 20) calculates that 50.4 per cent of the years in Coquimbo will have rainfall equal to or less than average. In other words, the majority of the years are extreme years—years with very little precipitation or above-normal precipitation.

Although Coquimbo has had many periods of excessive drought that have resulted in heavy crop and livestock losses, the majority of the *campesinos* have made little or no attempt to adjust their land-use activities accordingly. There is a strong belief among Chileans that the destruction of the vegetation of much of Coquimbo has caused decreasing precipitation and droughts (Gay, 1838, pp. 2-3; Reyes Zárate, 1957, pp. 20-21; Echegoyen, 1917, pp. 22-24). Nearly every *campesino* invariably blames some tribulation on the

drought. The *sequías* are a common excuse for damage caused by man's mismanagement of resources, although climatological records show that Chile has always had droughts. Table 1 shows the severity of livestock losses in Coquimbo and Atacama during the *sequía* of 1830-32. A drought which began in 1967 was responsible for reducing the goat population from 341,145 in 1965 to around 70,000 in 1970 (Aranda, 1971b, p. 13). However, the latter figure seems much too low. To combat drought periods the government created the Comisión Nacional de la Sequía (National Commission on Drought). That commission handles a series of drought-related problems, foremost being the delivery of potable water to rural areas during drought periods. Not only are livestock losses great during droughts but irrigation water is scarce and consequent crop damage severe. *El Mercurio* (November 16, 1971, p. 39) comments: "San Isidro continues punishing the north. In the present year we have had the greatest precipitation since 1967–68 mm–a little better than nothing; in 1969, precipitation was 18 mm; and that of 1970, 33 mm." Heavy storms toward the end of August, 1972, brought that drought to an end.

The periodic floods in Coquimbo are nearly as disastrous as the droughts. Vicuña Mackenna (1877, p. 315) remarks on a flood that occurred on March 10, 1856:

> Nevertheless, on this occasion it rained eighty hours in the Valley of Coquimbo: all the rivers left their courses causing incalculable damage to the harvests, and especially to the crops that have not been stored yet. In La Serena, the river that runs through it and with great effort makes it fertile, flowed from bank to bank, and even threatened to invade the city by the district of Santa Inés.

Partially because of the dry summers, transhumance is practiced in northern Chile, and in summer the livestock are usually taken to pastures (*veranadas*) in the high cordilleras of the Andes. The *vegas* (mountain meadows) are in such a state of deterioration, however, that during the dry season more and more animals are being taken south to the humid provinces.

Everyday occurrences along the coast are low stratiform clouds, ground fog, and mists formed by warm air blowing over the cold offshore waters and by differential heating of sea and land air in the inversion layers (Schmithüsen, 1956, p. 55). These low stratus clouds and advection fogs, called *camanchacas* in northern Chile, are frequently condensed into mists against the seaward-facing slopes of the coast ranges, providing a very significant supplement to average annual rainfall. The *camanchacas* penetrate some distance inland up the transverse valleys before they dissipate with the higher temperatures and considerably drier atmosphere of the interior. Many of the so-called *camanchacas* in the high Andean valleys, however, are stratus clouds associated with advancing cyclonic fronts or radiation fogs. In general, the *camanchacas* are confined by the lower level of the regional temperature inversion which lies between 750 and 1050 meters above sea level (Schneider, 1969, pp. 43 and 65) (see plate 2).

Kummerow (1966, pp. 21-24), in his studies on fog precipitation in the forest microclimates of Fray Jorge in the Altos de Talinay, found that precipitation from the *camanchacas* on the seaward-facing slopes at elevations of 500 to 600 meters was up to ten times the average annual rainfall for the region. The fog condenses on the branches of the trees and drips to the ground. This tremendous supplement to annual rainfall has allowed a Valdivian type of forest association to survive in a region of predominantly xerophytic scrub (see plate 3). Table 2 shows measurements of rainfall and fog precipitation for Fray Jorge in 1962-1965.

Long before Kummerow verified the amount of fog precipitation at Fray Jorge, however, *campesinos* were collecting fog condensation by putting pans under trees in these same forests during periods of drought. This practice was confined to patches of cloud forest, now cut down, that apparently once existed on the high seaward-facing slopes of the coast ranges from Los Vilos to Fray Jorge. All vegetation along the coast, however, is

Table 1
Livestock Losses in the Provinces of Coquimbo and Atacama During the Drought of 1830-1832[a]

TOWN	CATTLE	HORSES	MULES	BURROS	SHEEP	GOATS	TOTAL
Copiapó	1,137	236	358	491	2,663	831	5,766
Vallenar	473	173	700	2,300	583	2,500	6,729
Freirina	500	250	550	800	1,500	3,300	6,900
Elqui	7,119	900	410	139	7,314	5,110	20,992
Serena	17,636	932	434	2,237	20,821	26,805	68,865
Ovalle	35,678	4,029	1,491	1,037	119,465	106,484	268,184
Combarbalá	3,800	1,700	600	340	26,030	28,045	60,515
Illapel	10,600	1,650	650	975	25,000	38,500	77,375
Total	76,943	9,920	5,193	8,319	203,376	211,575	515,325

[a]After Benavente (1832, p. 4).

Table 2
Measurements of Rain and Fog Precipitation
at Fray Jorge in the Altos de Talinay[a]

	1962	1963	1964	1965[b]
Rainfall	78.7 mm	271.6 mm	59.5 mm	326.0 mm
Fog precipitation	597.9 mm	534.9 mm	859.8 mm	651.1 mm
Total precipitation	676.6 mm	806.5 mm	919.3 mm	977.1 mm

[a]After Kummerow (1966, p. 22).
[b]Only the precipitation recorded from January to September.

substantially benefited by the *camanchacas*, not only from the additional moisture actually precipitated but also from the reduced evaporation and lower temperatures.

Another weather phenomenon of interest in Coquimbo is the *garúa mata pajaritos*, "the drizzle that kills little birds," which occurs in early spring and is characterized by long periods of drizzle, associated with *camanchacas* and passing cold fronts. "In the spring when the baby birds are still in the nest and do not yet have their feathers, the mother bird leaves the nest and the mist chills the babies and kills them" (Vicuña, 1971, personal communication).

A transect from the Pacific Ocean to the tops of the Cordillera de los Andes exhibits a progressive increase in rainfall, greater variations in diurnal and annual temperatures, a decrease in relative humidity (the average relative humidity of the coast is 80 per cent or higher) (Fuenzalida Ponce, 1967, p. 131), and cloudiness (50 per cent of the days are overcast on the coast) (Almeyda Arroyo and Saez Solar, 1958, p. 167). According to a map by Almeyda Arroyo and Saez Solar (1958, p. 151), isotherms of average annual temperatures trend north-south in Coquimbo, paralleling the general longitudinal structures of Chile. Since only fourteen weather stations presently collect temperature data in Coquimbo, and most of them are in the bottoms of the major valleys, the isotherms indicated for the Province are based on highly unreliable extrapolation. Temperatures in the high cordilleran valleys are affected by diurnal drafts, and temperature extremes are usually less in the high valleys than in the lower valleys. The coast is characterized by moderate temperatures (La Serena has an average annual mean temperature of 14.7°C) and the average mean temperature difference between the coolest and warmest months is only 5 to 7°C (Fuenzalida Ponce, 1967, p. 130). Inland from the littoral fringe, below freezing temperatures and frosts are common, although frosts are sometimes recorded on the coast at Choros Bajos, Hacienda Tangue, Huentelauquén, and Quilimarí.

Much emphasis has been placed on explaining vegetation changes in modern times in Chile as a result of climatic change. The Pleistocene glacial and pluvial geomorphology of northern Chile suggests pronounced climatic changes since the end of the Tertiary. Indeed, mediterranean-type climates are thought to be Pleistocene manifestations and will disappear when the polar icecaps melt, returning summer rainfall to the regions where this climatic type obtains at present (Axelrod, 1971, personal communication). The vegetation communities at Fray Jorge (relict?), the red-paleo soils of the Limarí plain, and the occurrence of gray-brown forest soils in areas presently covered by xerophytic scrub all point to climatic change (di Castri, 1968, pp. 6 and 27; di Castri and Hajek, 1976). Since the end of the Pleistocene, however, there is little evidence for climatic change, although some evidence may point to a trend toward greater aridity in northern and central Chile (di Castri, 1968, p. 29; Schneider, 1969, pp. 49-50). This trend, though supported with scant climatic data, is

Table 3
Data Purporting to Show a Trend Toward a Drier Climate in the Province of Coquimbo

LOCATION	YEARS	AVERAGE ANNUAL PRECIPITATION
La Serena	1869-1964	125.4 mm
	1871-1900	148.2 mm
	1901-1930	128.3 mm
	1931-1960	104.7 mm
Ovalle	1897-1964	143.0 mm
	1901-1930	152.6 mm
	1931-1960	125.8 mm

probably more a function of microclimatic changes in Coquimbo due to man's destruction of the natural vegetation than to a regional climatic shift toward aridity. Not only has man brought about microclimatic changes in Coquimbo, but his inefficient use of irrigation water and increased water needs have heavily overtaxed the meager if perennial flow of the snow-fed streams of the Province, imparting a greater sense of aridity stemming from the scarcity of irrigation water created by expanded agricultural demands. Millions of dollars have been spent in Coquimbo on damming impoundment areas that may never fill: Recoleta, Cogotí, Culimo, and Paloma (one of the largest dams in South America). Even with more efficient use of existing irrigation water there is doubt whether the major streams will be able to satisfy future water needs. Schneider (1969, pp. 49-50) points to a drying trend in the last century in Coquimbo on the basis of data in table 3 for La Serena and Ovalle.

Pejml (1966), in his study on climatic changes in historic times on the west coast of South America, however, notes that fluctuations in climate can be demonstrated, but not changes. He contends that drought indices computed for middle and north Chile for the period 1690 to 1930 prove that the severest droughts occurred within the period from 1781 to 1810, and that fluctuations in climate are caused by extreme shifts in the Intertropical Convergence Zone and by changes in the magnitude of the Humboldt Current.

The destruction of the natural vegetation of much of Coquimbo has led to microclimatic change, ecological regression, and the appearance of vegetation types that do not correlate with existing regional climatic patterns. The greatly increased desiccation within the plant communities, and the consequent spreading and invasion of xerophytes, is due to biotic factors, not to major local and regional climatic change.

VEGETATION

Similar to the topography and climate with which it is so closely associated, the vegetation of Coquimbo varies from north to south and from east to west.[7] Because of the Province's great ecological variability, it includes a relatively high number of the 182 families and nearly 6000 species of flowering plants encountered in Chile.[8] Coquimbo is well known taxonomically despite an absence of information on phytogeography and plant environmental relationships. Prerequisite to rational management of the soils and other renewable

7. Special thanks are extended to Eugenio Sierra Râfols, who keyed hundreds of plants collected by the author.

8. See Appendix A: Principal Wild Vascular Plants of Coquimbo Province.

resources in the Province is an accurate knowledge of the wild vegetation of Coquimbo and the making of detailed vegetation maps.[9]

Except for the sedges and dwarf shrubs of the high peaks of the Andes, the chaparral communities of the southwest coastal region, and the gallery forests of the river valleys, the wild vegetation of Coquimbo is predominantly low xerophytic scrub with widely scattered columnar cacti and thorny and/or sclerophyllous evergreen and deciduous trees (see map 4). As can be seen on the rainfall map (see map 3), few areas in Coquimbo have over 300 mm of average annual precipitation. Even along the coast, with its high incidence of cloudiness, frequent fogs, and low temperatures, the vegetation is basically scrub. The Province of Coquimbo is situated between the almost completely barren Atacama Desert, to the north, and the mediterranean-type chaparral communities and low sclerophyllous woodlands of central Chile. A gradual change from widely spaced, low xerophytic scrub and cacti, in the north, to a dense mixed xerophytic and mesophytic chaparral, in the south, is accompanied by a gradual change in the floristic composition, as the desert species of the north meet and mingle with the more mesophytic species of central Chile. Likewise, floristic and community changes occur from west to east (see figure 2). A number of species are ubiquitous in the Province and are found in a number of widely varying communities, although in different densities. In most cases, changes in vegetation in Coquimbo are less along north-south transects than along west-east transects, where vast ecological changes over short distances are a response to pronounced differences in relief and elevation. Changes in vegetation along any gradient are a response to differences in elevation, soil, precipitation, insolation, humidity, and other natural phenomena. Radical local changes, however, may result from biotic disturbances, differences in exposure, availability of ground water, variation in air

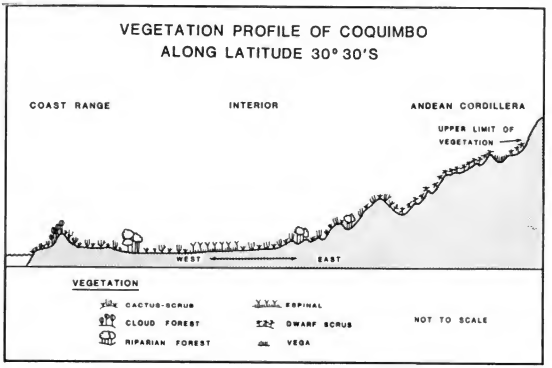
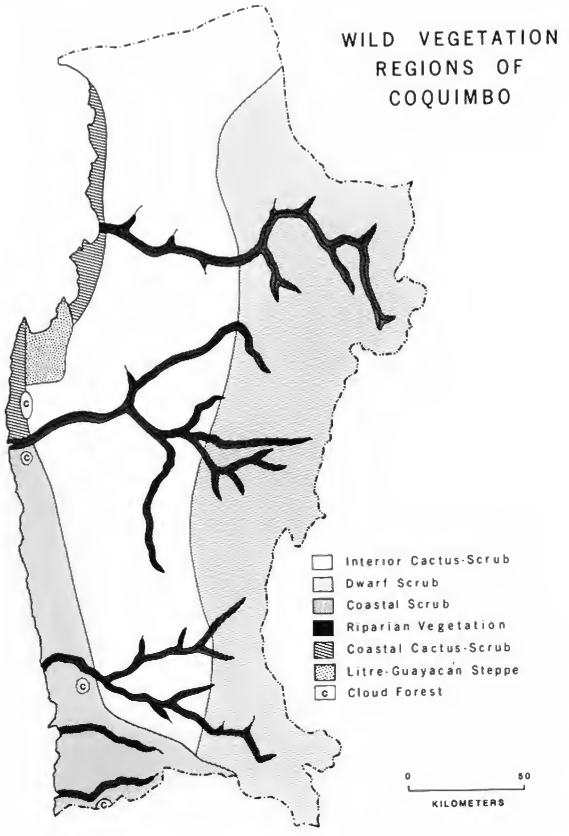


Fig. 2. Vegetation profile of Coquimbo along latitude 30°30'S.

9. Although there is a large literature on the wild vegetation of the Province of Coquimbo, the most helpful works in preparing this section were: Reiche (1934, I), Schmithüsen (1956), Muñoz Pizarro (1965; 1966a and b), Goodspeed (1945), di Castri (1968), Hernández (1970), Jiles (1963), Pisano Valdés (1966a and b), Fuenzalida Villegas (1967), Almeyda Arroyo (1943), Mooney (1977), Mooney and Schlegel (1966), and Willis (1973).



Map 4. Wild vegetation regions of Coquimbo.

drainage, and a host of other natural factors. Indeed, man-caused disturbances in the nature and characteristics of the wild vegetation of Coquimbo are so manifold and profound that it would be difficult if not impossible to establish climax communities in equilibrium with existing regional climatic parameters.

The wild vegetation of the Province can be divided into two classes: perennial plants, which may be succulent but more often are dwarfed and woody; and annuals, which appear after the winter rains and complete their growth cycles during a short season. Annuals often constitute half of the total species in a community, and many of the annual and perennial herbs are introduced and/or naturalized. According to Zohary (1962), the combination of mild, moist winters and summer droughts in mediterranean climates is especially suitable for the growth of annual plants, so it is not surprising that they have achieved such preeminence in central and northern Chile. The ephemerals which appear after the winter rains form fairly dense stands and provide a short season of forage. The once-abundant perennial bunch grasses have been heavily depleted by overgrazing and are nearly extinct in most of Coquimbo. Numerous spring-blooming annuals and perennials give Coquimbo a polychromatic vegetation cover after the winter rains, especially in the coastal areas, that is matched by few places in the world.[10] Many of these flowers are collected by the *campesinos* and used for decoration or sold. Species of *Alstroemeria, Hippeastrum, Leucocoryne, Tropaeolum,* and *Tecophilaea* have been exported from Chile for gardening (Bailey, 1925; Muñoz Pizarro, 1966b). In fact, both Jiles and Muñoz Pizarro attribute the depletion of certain unusual species of cacti in northern Coquimbo to the growing export of cacti to Japan and Europe (1971, personal communication).

Introduced or naturalized herbs and/or weeds have a numerical ascendancy over native herbs in most of Coquimbo. Most species are native to the Mediterranean region, though there are also some from Asia, Africa, Australia, and a few species which have been introduced from California. They are generally limited to specialized habitats maintained by man, such as roadsides, paths, railroad rights-of-way, and cultivated fields. Many weedy species, however, have escaped from agricultural areas and have become part of the wild vegetation. They have replaced or displaced native species and become well-established, even dominant, in some areas. Introduced or naturalized herbs are valuable forage plants in Coquimbo, and in most of the Province make up the bulk of the annual herbaceous forage; e.g., in one pasture near Monte Patria the herbaceous cover was almost completely exotic, consisting predominantly of *Erodium cicutarium, Plantago lanceolata, Cirsium lanceolatum, Anagallis arvensis, Urospermum picroides,* and *Anthemis cotula.*[11]

A common problem underlying a description of the historical relation between man and wild vegetation—indeed, a common problem in measuring the history of vegetation change—is the need to reconstruct or postulate the nature and characteristics of the plant cover at various points in the past. Some would go so far as to postulate a static "pristine" vegetation cover before the arrival of man, and from that base proceed to estimate the extent to which thousands of years of human influence have disturbed a previously undisturbed situation—a formidable task. Even where land-use histories are fairly well known and early descriptions

10. Some species of outstanding beauty are: *Alona rostrata, Alonsoa incisifolia, Alstroemeria gayana, Alstroemeria sierrai, Argylia radiata, Balbisia peduncularis, Calandrinia crassifolia, Calandrinia discolor, Centaurea chilensis, Hippeastrum bicolor, Leucocoryne purpurea, Mutisia spectabilis, Nolana paradoxa, Placea amoena,* and *Schizanthus litoralis.* For more information on the wild flowers of Coquimbo see Muñoz Pizarro (1965; 1966b).

11. Some exotic herbs found in Coquimbo are noted in Appendix A. Information on exotics was obtained from Matthei (1963), Muenscher (1955), Munz (1959), Muñoz Pizarro (1966a), Philippi (1875), and Robbins *et al.* (1941).

of the vegetal cover are available, however, it is difficult to gain a comprehensive understanding of the effects of centuries, if not millennia, of human disturbance on the structure and composition of existing vegetation.

The task of measuring highly specific man-caused changes in the vegetal cover of Coquimbo is made doubly difficult by the poorness of the archeological record of more than 6500 years of aboriginal impact on the land, and by lack of historical records describing the vegetation from the period of the first Spanish *entradas* to the late eighteenth century. Except for extensive archival records, which provide little information on past plant cover and land use, one has to rely mostly on nineteenth- and twentieth-century literature and records in order to reconstruct land-use histories, former vegetation cover, and the nature of the ecological relations between man and the wild vegetation of Coquimbo. A useful method for studying historical ecological relations between man and the land in Coquimbo, however, lies in observing the *campesino*, who utilizes the land in much the same manner and with the same degree of self-sufficiency as did his forefathers. Hence, patterns of human activities that have influenced the vegetal cover of north-central Chile for more than four centuries can be observed and studied today.

An inspection of large-scale vertical aerial photographs of the Province shows that few areas outside the high summits of the Andes have escaped anthropogenic influences.[12] Regression of the vegetation due to activities of man has created microclimatic disturbances of such magnitude that one cannot help but feel that he is dealing with a host of seral communities in parts of Coquimbo. In many areas of the Province, a return to a climax community in harmony with existing regional climatic parameters is unlikely because man-caused disturbance in most plant communities is so extensive.

In contrast to popular notions, there is no evidence to suggest that Coquimbo was ever forested during historical times. Aside from areas that have been completely cleared, the areas where endemic shrubs and trees abound, even if heavily disturbed by the activities of man, probably have a gross physiognomy very similar to that encountered by the first Spanish invaders.

Climatic parameters influence the distribution, physiognomy, and floristic composition of the plants encountered in Coquimbo. The summers are dry and hot, and the winters are cool and moist; thus, plant growth outside the high Andes is active in winter and spring, and inactive in summer except in the Andes and along the coast (di Castri, 1968, p. 22). Many of the plants complete their growth during one or two months of early spring while the ground is moist, and then spend the summer in a resting condition, storing food in bulbs or underground stems that will enable them to make a vigorous start in the following spring. Except in drainage ways, the perennial plants of northern Coquimbo are widely spaced on the dry interfluves in order to have a large gathering ground for soil moisture. To decrease water losses, many of the perennials have leaves which possess adaptations to reduce the rate of transpiration and the total area of leaf surface. Some perennials are leafless in summer, while others are leafless or almost leafless at all times. The mesophytes also have adaptations to escape or delay drought damage. Even with their adaptations to aridity, however, numerous perennial plants die out during the long periods of drought. The short-lived annuals or ephemerals, which complete their life cycles in a brief period, are drought-escaping rather than drought-enduring, for they pass the extreme summers and long periods of drought in the form of seeds (Wilsie, 1962, p. 164).

12. Conventional 9 x 9-inch panchromatic photographs taken in 1955 at a scale of 1:70,000 were used. René Saa, of the Instituto de Investigaciones de Recursos Naturales, was instrumental in obtaining these air photos for the author.

Succulents abound in the Province and can accumulate large quantities of water in their tissues to be used when soil moisture cannot supply enough water for plant requirements. Many plants in Coquimbo endure the dry summers and long periods of drought via structural characteristics such as wide-spreading deep root systems, small transpiration surfaces in proportion to root surfaces, reduction of leaf area when moisture stress develops, few or embedded stomata, and thick cutinous layers. Most trees, especially in the northern portions of the Province, are phreatophytes, found along dry stream channels in valley floors. Only in the southern portions of the Province, and along the heights of the seaward-facing slopes of the coast ranges where moisture is more plentiful, are trees found in abundance outside of phreatophytic or riparian situations.

Dew and fog precipitation probably play two roles which benefit vegetation in coastal Coquimbo. The first of these is the passive role in which dew delays the rise in temperature and the onset of transpiration stress (Wilsie, 1962, p. 137); the second is the active role in which dew and fog precipitation, as demonstrated by Kummerow at Fray Jorge (1966, pp. 21-24), are taken up by the plant and enter the dynamic liquid cycle.

Aspects of topography of particular significance in the distribution of plant communities in Coquimbo are slope exposure to sun and marine influences; vegetation often contrasts greatly between north- and south-facing as well as east- and west-facing slopes. Since, south of the Equator, southern exposures face away from the sun, they are usually cooler and moister; and as a result the vegetation throughout the Province (allowing for man-caused microclimatic changes and/or edaphic differences) is denser and richer in species on south-facing slopes, than on north-facing slopes. Likewise, especially at lower elevations, desert species with high tolerances for drought and sunlight are usually encountered on north-facing slopes or in the lee of marine influences. One community frequently encountered on north-facing slopes in the interior of Coquimbo from the Río Elqui to the southern border of the Province is the *cardonal,* a community dominated by large columnar cacti (*Trichocereus* spp. and *Eulychnia* spp.) and *Flourensia thurifera.*

In terms of sources of moisture supply, the vegetation of the Province can be divided into two general types: vegetation which is dependent upon the local accumulation of rainfall in drainage courses and depressions; and vegetation which is dependent upon moisture from sources outside the region, such as the major exotic rivers of the transverse valleys and the coastal fogs (*camanchacas*). The depth and physical texture of the soils in Coquimbo are also reflected in the vegetation, but little is known about the soils of the Province outside the river valleys, especially in terms of how they influence the amount, availability, and continuity of water supply.

The mediterranean and semidesert flora of Coquimbo must be viewed as part of the continuing evolution of subhumid and semiarid plant communities at the margins of the tropics. All mediterranean areas of the southern hemisphere are totally cut off not only from every other region with a similar climate but also from any well-developed temperate flora.

> Even though Antarctica was populated by plants in Cretaceous time, and provided a direct path for migration for some plants (e.g., *Nothofagus* and Podocarps) between at least South America and Tasmania-New Zealand, this could not have had any effect upon the composition of the mediterranean flora of Chile [Raven, 1973, p. 218].

In effect, the mediterranean areas of Chile did not have the vast gene pool of temperate species to draw from that similar climatic regions had in the northern hemisphere. In summary, the following statements can be made about the evolution of the flora of Coquimbo and the rest of central and north Chile: the flora developed in isolation; "it evolved almost entirely from border tropical, not temperate predecessors"; and, finally, "the

climate in Antarctica in the Cretaceous was never sufficiently arid to allow the passage of the plants and animals of semiarid or subhumid regions between South America and the Old World" (Raven, 1973, p. 220).

In the northern part of Coquimbo, where rainfall along the coast and in the interior is less than 150 mm a year, one encounters a vegetation composed of widely spaced low woody shrubs. Table 4 lists some of the common shrubs and bushes of the mountainous

Table 4
Wild Vascular Plants of Coquimbo at Selected Sites

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
A. CUESTA DE PAJONALES			
Adesmia spp.	*barilla*		
Baccharis spp.	--		
Balsamocarpon brevifolium	*algarrobilla*		
Bulnesia chilensis	*retamilla*		
Chuquiraga spinosa	*chana*		
Colliguaja odorifera	*colliguay*		
Cordia decandra	*carbón* or *carbonillo*		
Encelia tomentosa	*coronilla de fraile*		
Ephedra andina	*pingo-pingo*		
Gutierrezia paniculata	*pinchanilla*		
Heliotropium stenophyllum	*palo negro*		
Lycium sp.	--		
Muehlenbeckia hastulata	*quilo* or *mollaca*		
Pintoa chilensis	--		
Pleocarphus revolutus	*cola de ratón*		
Proustia baccharoides	*huañil*		
B. QUEBRADA DE TALCA			
Adesmia spp.	*barilla*		
Bahia ambrosioides	*chamiza*		
Baccharis spp.	--		
Buddleja globosa	*matico*		
Cassia sp.	*alcaparra*		
C. stipulacea	*alcaparra*		
Cestrum parqui	*palqui*		
Colletia sp.	*chacai*		
Cordia decandra	*carbón* or *carbonillo*		
Ephedra andina	*pingo-pingo*		
Flourensia thurifera	*maravilla del campo*, or *incienso*		
Fuchsia sp.	*palo blanco*		
Haplopappus spp.	--		
H. foliosus	*cuerno de cabra*	*Porlieria chilensis*	*guayacán*
Heliotropium stenophyllum	*palo negro*	*Prosopis chilensis*	*algarrobo*
Lithraea caustica	*litre*	*Proustia baccharoides*	*huañil*
Maytenus boaria	*maitén*	*P. pungens*	*palo de yegua*
Muehlenbeckia hastulata	*quilo*	*Schinus polygamus*	*molle*
Nicotiana glauca	*palqui extranjera*	*Solanum* spp.	*hierba de chava-longo, natri*, or *huevil*
Ophryosporus triangularis	*rabo de zorro*		
Oxalis gigantea	*churqui* or *churco*		
Pleocarphus revolutus	*cola de ratón*	*Tessaria absinthioides*	*brea*

Table 4 (continued)

SCIENTIFIC NAME	COMMON NAME
C. CUESTA EL ESPINO	
Acacia caven	*espino* or *churqui*
Adesmia spp.	*barilla*
A. arborea	*paihuén*
Aristotelia chilensis	*maqui*
Baccharis spp.	--
B. rosmarinifolia	*romero de la tierra*
Calceolaria spp.	*capachita*
Cassia spp.	--
Cestrum parqui	*palqui*
Colliguaja odorifera	*colliguay*
Cordia decandra	*carbón* or *carbonillo*
Cryptocarya alba	*peumo*
Diostea juncea	*retama*
Drimys winteri	*canelo*
Escallonia pulverulenta	*corontillo*
Fabiana imbricata	*pichi-romero*
Flourensia thurifera	*maravilla del campo*
Gymnophyton robustum	*biobío*
Heliotropium stenophyllum	*palo negro*
Lithraea caustica	*litre*
Maytenus boaria	*maitén*
Muehlenbeckia hastulata	*quilo* or *mollaca*
Myrceugenia spp.	*arrayán*
Peumus boldus	*boldo*
Proustia baccharoides	*huañil*
P. pungens	*palo de yegua*
Psoralea glandulosa	*culén*
Puya spp.	*cardón* or *chagual*
Quillaja saponaria	*quillay*
Salix spp.	*sauce*
Schinus dependens	*molle*
S. molle	*molle*
S. polygamus	*huingán*
Solanum crispum	*natri*
Talguenea quinquenervia	*talhuén*
Tetraglochin sp.	--

SCIENTIFIC NAME	COMMON NAME
D. BETWEEN HUINTIL AND CAREN	
Acacia caven	*espino*
Baccharis spp.	--
Cassia closiana	*quebracho*
Colliguaja odorifera	*colliguay*
Cordia decandra	*carbón* or *carbonillo*
Gutierrezia paniculata	*pinchanilla*
Heliotropium stenophyllum	*palo negro*
Lithraea caustica	*litre*
Muehlenbeckia hastulata	*quilo* or *mollaca*
Proustia spp.	--

SCIENTIFIC NAME	COMMON NAME
E. EL PALQUI	
Acacia caven	*espino*
Adesmia spp.	*barilla*
Aristotelia chilensis	*maqui*
Baccharis spp.	--
Cassia closiana	*quebracho*
Cestrum parqui	*palqui*
Colliguaja odorifera	*colliguay*
Cryptocarya alba	*peumo*
Drimys winteri	*canelo*
Ephedra andina	*pingo-pingo*
Escallonia spp.	--
Eupatorium glechonophyllum	*pega-pega*
E. salvia	*pegajosa*
Flourensia thurifera	*incienso*
Haplopappus spp.	--
Kageneckia oblonga	*bollén*
Krameria cistoidea	*pacúl*
Lithraea caustica	*litre*
Lobelia salicifolia	*tupa*
Maytenus boaria	*maitén*
Muehlenbeckia hastulata	*quilo*
Myrceugenella chequen	*arrayán*
Myrceugenia spp.	*arrayán*
Ophryosporus triangularis	*rabo de zorro*
Peumus boldus	*boldo*
Porlieria chilensis	*guayacán*
Prosopis chilensis	*algarrobo*
Proustia baccharoides	*huañil*
Psoralea glandulosa	*culén*
Puya spp.	*cardón* or *chagual*
Quillaja saponaria	*quillay*
Salix chilensis	*sauce*
Schinus dependens	*molle*
S. polygamus	*huingán*

SCIENTIFIC NAME	COMMON NAME
F. BOTTOMS OF *QUEBRADAS* BETWEEN LOS VILOS AND PICHIDANGUI	
Adenopeltis colliguaya	*colliguay macho*
Azara celastrina	*lilén*
Baccharis concava	*guacho*
Bahia ambrosioides	*chamiza*
Crinodendron patagua	*patagua*
Cryptocarya alba	*peumo*
Escallonia pulverulenta	*corontillo*
Eulychnia castanea	*copao*
Eupatorium glechonophyllum	*pega-pega*
E. salvia	*pegajosa*
Lithraea caustica	*litre*
Lucuma valparadisea	*lúcumo*
Maytenus boaria	*maitén*

Table 4 (continued)

SCIENTIFIC NAME	COMMON NAME
Myrceugenella chequen	*arrayán*
Puya venusta	*chagual*
Salix humboldtiana	*sauce*
Schinus latifolius	*molle*

G. WOODY THICKETS ON THE HIGH PEAKS OF THE COAST RANGES

Aristotelia chilensis	*maqui*
Azara spp.	*lilén*
Cryptocarya alba	*peumo*
Drimys winteri	*canelo*
Escallonia pulverulenta	*corontillo*
Eupatorium salvia	*pegajosa*
Kageneckia oblonga	*bollén*
Muehlenbeckia hastulata	*quilo*
Myrceugenella spp.	*arrayán*
Peumus boldus	*boldo*
Proustia pyrifolia	*bosque*
Quillaja saponaria	*quillay*
Ribes sp.	--
Schinus latifolius	*molle*
Senecio sp.	--

H. MARSHY THICKETS BETWEEN CALETA NAGUE AND CALETA AMARILLA

Aristotelia chilensis	*maqui*
Baccharis spp.	--
Cissus striata	*zarzaparrilla*
Drimys winteri	*canelo*
Escallonia revoluta	*siete camisas*
Eupatorium salvia	*pegajosa*
Lithraea caustica	*litre*
Maytenus boaria	*maitén*
Muehlenbeckia hastulata	*quilo*
Myrceugenella chequen	*arrayán*
Peumus boldus	*boldo*
Psoralea glandulosa	*culén*

I. CLOUD FORESTS OF FRAY JORGE AND TALINAY

Aextoxicon punctatum	*olivillo*
Aristotelia chilensis	*maqui*
Baccharis concava	*guacho*
Blechnum auriculatum	*palmilla*
Drimys winteri	*canelo*
Griselinia scandens	*yelmo*
Mitraria coccinea	*botellita*
Myrceugenella correaefolia	*arrayán*
Nertera depressa	*coralito*
Peperomia nummularioides	*congonilla del monte*
Puya spp.	*cardón* or *chagual*
Rhaphithamnus sp.	*arrayán*
Sarmienta repens	*votri*

J. COASTAL *MATORRAL* NEAR LOS VILOS

Adenopeltis colliguaya	*colliguay macho*
Adesmia arborea	*paihuén*
Azara spp.	*lilén*
Bahia ambrosioides	*chamiza*
Baccharis spp.	--
Cassia closiana	*quebracho*
Cestrum parqui	*palqui*
Chorizanthe sp.	--
Colletia spinosa	*crucero*
Colliguaja spp.	*colliguay*
Cryptocarya alba	*peumo*
Escallonia sp.	--
Eupatorium glechonophyllum	*pega-pega*
E. salvia	*pegajosa*
Flourensia thurifera	*incienso*
Fuchsia sp.	--
F. lycioides	*palo blanco*
Gutierrezia paniculata	*pinchanilla*
Haplopappus spp.	--
Lithraea caustica	*litre*
Lobelia salicifolia	*tupa*
Margyricarpus sp.	*perlilla*
Maytenus boaria	*maitén*
Muehlenbeckia hastulata	*quilo*
Myrceugenella chequen	*arrayán*
Peumus boldus	*boldo*
Proustia spp.	--
Puya spp.	*cardón* or *chagual*
Quillaja saponaria	*quillay*
Schinus spp.	--
Senecio spp.	--

K. RIVADAVIA

Adesmia spp.	*barilla*
Baccharis spp.	--
Bahia ambrosioides	*chaniza*
Bridgesia incisaefolia	*rumpiato*
Chuquiraga spinosa	*chana*
Cordia decandra	*carbón* or *carbonillo*
Cruckshanksia spp.	--
Encelia tomentosa	*coronilla de fraile*
Erodium cicutarium	*alfilerillo*
Escallonia spp.	*ñipa*
Flourensia thurifera	*maravilla del campo*

Table 4 (continued)

SCIENTIFIC NAME	COMMON NAME
Haplopappus spp.	--
Kurtzamra pulchella	*poleo del cordillera*
Larrea nitida	*jarilla*
Lobelia polyphylla	*tupa*
Malesherbia sp.	*farolito*
Malva spp.	--
Oxalis gigantea	*churco* or *churqui*
O. peraltae	--
Proustia baccharoides	*huañil*
P. pungens	*palo de yegua*
Trifolium spp.	--
Viola spp.	--

L. CHOROS BAJOS

Adesmia spp.	*barilla*
Baccharis spp.	--
Bahia ambrosioides	*chamiza*
Bridgesia incisaefolia	*rumpiato*
Cassia spp.	*alcaparra*
Cestrum parqui	*palqui*
Cordia decandra	*carbón* or *carbonillo*
Encelia tomentosa	*coronilla de fraile*
Ephedra andina	*pingo-pingo*
Eriosyce ceratistes	*sandillón*
Eulyclunia acida	*copao*
E. spinibarbis	*guillave*
Fuchsia lycioides	*palo blanco*
Haplopappus spp.	--
Heliotropium stenophyllum	*palo negro*
Llagunoa glandulosa	*atutemo*
Lobelia salicifolia	*tupa*
Muehlenbeckia hastulata	*quilo* or *mollaca*
Neoporteria spp.	--
Ophryosporus foliosus	--
O. triangularis	*rabo de zorro*
Opuntia miquelii	*tunilla*
O. ovata	*leoncito*
Oxalis gigantea	*churqui* or *churco*
Pleocarphus revolutus	*cola de ratón*
Reicheia coquimbensis	*tucumillo* .
Solanum sp.	*hierba de chavalongo, natri,* or *huevil*
S. pinnatum	*hierba de chavalongo,*
Trichocereus chiloensis	*quisco*
T. coquimbensis	*copao*
T. skottsbergii	*quisco* or *guillave*
Triglochin palustris	*hierba de la paloma*

SCIENTIFIC NAME	COMMON NAME
M. ILLAPEL	
Acacia caven	*espino*
Adesmia spp.	*barilla*
A. arborea	*paihuén*
Aristotelia chilensis	*maqui*
Baccharis spp.	--
B. rosmarinifolia	*romero de la tierra*
Cassia closiana	*quebracho*
Cestrum parqui	*palqui*
Colliguaja odorifera	*colliguay*
Cryptocarya alba	*peumo*
Drimys winteri	*canelo*
Flourensia thurifera	*incienso*
Haplopappus spp.	--
Lithraea caustica	*litre*
Maytenus boaria	*maitén*
Muehlenbeckia hastulata	*quilo*
Peumus boldus	*boldo*
Pleocarphus revolutus	*cola de ratón*
Prosopis chilensis	*algarrobo*
Proustia baccharoides	*huañil*
P. pungens	*palo de yegua*
Psoralea glandulosa	*culén*
Quillaja saponaria	*quillay*
Schinus latifolius	*molle*
S. molle	*molle*
Solanum spp.	*hierba de chavalongo*
Talguenea quinquenervia	*talhuén*

N. TONGOY

Adesmia arborea	*paihuén*
Atriplex repanda	*sereno*
Baccharis spp.	--
Bahia ambrosioides	*chamiza*
Cassia sp.	*alcaparra*
Cestrum parqui	*palqui*
Colliguaja spp.	*colliguay*
Flourensia thurifera	*incienso*
Gutierrezia paniculata	*pinchanilla*
Haplopappus spp.	--
Heliotropium stenophyllum	*palo negro*
Muehlenbeckia hastulata	*quilo*
Proustia pungens	*palo de yegua*

slopes of Cuesta de Pajonales, on Coquimbo's northern border with the Province of Atacama.[13] The *algarrobilla* (*Balsamocarpon brevifolium*), a species endemic to northern Coquimbo and southern Atacama, makes its furthest penetration south into the Province near Vicuña; its seed pods, rich in tannin, have been the source for a flourishing tannin trade that developed during the nineteenth century (Reiche, 1934, I, p. 135).

The dry *quebradas* or arroyo bottoms in northern Coquimbo contain scattered stands of *chañar* (*Geoffroea decorticans*), a prominent species in the Norte Grande, and *algarrobo* (*Prosopis chilensis*), though they have been decimated by centuries of cutting. Also growing in the bottoms of the *quebradas* are *Cordia decandra, Baccharis* spp., *Schinus molle, Acacia caven,* and *Schinus polyganus.* Scattered among the low shrubs on the slopes are a few large columnar cacti, *Prosopis chilensis, Acacia caven,* and *Porlieria chilensis.* The last three species are ubiquitous in the Province and grow at considerable elevations in the cordilleran valleys. Outside of riparian situations, the shrubs of the northern interior of Coquimbo are seldom more than one or two meters high. A few herbaceous species, as well as some dwarf mesophytes, are encountered in places having high soil moisture. The ground between the shrubs is generally bare except after the infrequent winter rains, when the soil surface is covered with ephemerals. In summer, however, only the blades from a few xerophytic grasses can be seen on the ground. Some of the herbaceous species which flower after the winter rains are beautiful geophytes, such as *Alstroemeria, Leucocoryne,* and *Hippeastrum.*

As one proceeds south through the interior of Coquimbo the dominance of low xerophytic shrubs and columnar cacti persists, though the shrubs are larger and more species from the south are encountered. The vegetation around Rivadavia (see table 4), especially on the mountain slopes along the Río Cochiguas and the Río Turbio, is extremely xerophytic. The lower slopes and the alluvial fans are dominated by almost pure stands of enormous columnar cacti (see plate 4). Also frequently encountered are a variety of smaller cacti such as *Eriosyce ceratistes, Echinocactus ceratistes,* and *Opuntia* spp.

In the spring, after the winter rains, a varied and polychromatic vegetation occurs. Particularly beautiful are the flowers of species of *Argylia, Hippeastrum, Calandrinia,* and *Leucocoryne.* A frequent genus is *Tropaeolum,* hanging from bushes and cacti.

South of the Río Elqui the low-brush steppe of the interior, with scattered columnar cacti, persists to Cuesta el Espino, where the vegetation takes on a different aspect. Encountered around El Palqui are most of the same species found around Rivadavia (see table 4).

The point at which the vegetation in the interior aside from the major river valleys undergoes its greatest change is probably on the slopes of Cuesta el Espino, where the low scrub steppe of the north gives way to a high scrub with scattered low sclerophyllous trees and columnar cacti. The high (2-4 meters) woody scrub, known as *matorral*[14] or *monte* in Coquimbo, is similar physiognomically to the *garrigue* of Syria and Lebanon and on the moist south-facing slopes forms an almost continuous cover. The large columnar cacti are still found in abundance at Cuesta el Espino along with *cardón* or *chagual* (*Puya* spp.), especially on the dry north-facing slopes. Dense gallery forests thread their way through the *matorral* along drainage bottoms. Table 4 lists some of the prominent species encountered in the gallery forests and *matorral* on the slopes of Cuesta el Espino.

13. Table 4 includes lists of the vascular plant species collected by the author at the sites mentioned in the text. These lists give a picture of the dominant trees and shrubs found at these sites. The common names of the species are also noted.

14. Though *matorral* and chaparral are frequently used to describe similar structural types of vegetation in Chile, *matorral* is used here to describe a degraded chaparral. See Tomaselli (1977, pp. 40-41) for a review of the definitions of *matorral, maquis, garrigue,* etc.

Nearly everywhere in the Province where water comes close to the surface are found dense thickets of *Myrceugenia* sp., *Maytenus boaria, Baccharis* spp., *Drimys winteri, Escallonia* spp., *Schinus* spp., *Salix* sp., and *Aristotelia chilensis.* In the southern portions of the Province those species are intermingled with *Peumus boldus, Cryptocarya alba, Azara* spp., and *Crinodendron patagua.* The thickets around springs have probably been preserved by the common belief that cutting trees and shrubs around a stream or spring will cause the water source to dry up.

Riparian forests occur along the bottoms of all the major transverse valleys and most of the tributaries having permanent water in them. Except for a few woodlands in southern coastal Coquimbo, woody thickets around surface water, and cloud forests in the coast ranges, the only wooded areas of any significance that the early Spanish *entradas* encountered were in the river valleys. Of course, most of those riparian forests have been so decimated by clearing for irrigated crops and woodcutting that the river valleys presently show little evidence of once having had dense forests. Only immediately adjacent to the streams or in the high valleys of the Andes has the plant cover been protected.

Unlike the vegetation of the interfluves, which depends on local precipitation and reflects precipitation changes from north to south, the riparian forests of Coquimbo have practically similar species from south to north, and floristic change reflects elevational differences, air drainage, and environmental factors more than moisture supply. Many river valleys have been reforested with eucalyptus, poplar, pine, cypress, and a wide variety of fruit trees; indeed, the river valleys support an almost completely exotic vegetation cover. The high Andean valleys in Coquimbo are renowned in Chile for their temperate fruits. Grapes are also widespread in the high valleys, and Chile's finest *pisco,* a grape alcoholic distillate, comes from the provinces of Coquimbo and Atacama. Furthermore, a wide variety of introduced and naturalized weeds run rampant in the valleys; even certain indigenous plants such as *Tessaria absinthioides, Pleocarphus revolutus,* and *Baccharis* spp. have taken on aspects of weeds and spread into disturbed areas. As a rule, the structure and floristic composition of the riparian vegetation changes as one moves upstream, in conjunction with altitudinal, temperature, insolation, and edaphic changes, until at the high elevations only a few hydrophytes, usually Cyperaceae and Juncaceae, are found in marshy areas.

The wild riverine vegetation of the major valleys is so disturbed that one can only speculate on the nature of the vegetal cover found there in prehistoric times. Since the riparian forests occur in the only large areas having perennial water for irrigation, those forests were the first areas of the wild vegetation to feel the impact of man in a major way.

The *espinal* or *espino* savanna is another community which is conspicuous in Coquimbo. It abounds in the interior portions of the Province where the atmosphere is dry, and is generally found at low elevations. Its northernmost penetration is near Samo Alto. The *espinal* is dominated by the thorny *espino* (*Acacia caven*) and to a lesser degree by two other trees: *guayacán* (*Porlieria chilensis*) and *algarrobo.* The general aspect of the *espinal* is that of a more or less open thicket of trees and spiny bushes with a rich ground cover of spring-blooming ephemerals and scattered perennial bunch grasses.

There are numerous opinions as to whether the *espinal* is a natural or man-made association. Many authors (Olivares and Gastó, 1971; di Castri, 1968; Reiche, 1934, I; Schmithüsen, 1956; Pisano Valdés, 1966b) have concluded that the *espinal,* at least in central Chile, represents a regression of a more evolved climax community dominated by *litre* (*Lithraea caustica*) and *quillay* (*Quillaja saponaria*), and that anthropogenic influences, largely the cutting out of *litre* and *quillay,* has made *espino* the dominant species in a stage of natural equilibrium inferior to the climatic climax. According to di Castri (1968, p. 19), soil-fauna studies support the thesis that *espinales* are man-made because cosmopolitan

populations are more numerous in those *Acacia* savannas, decreasing in the sclerophyllous woodlands of *litre* and *quillay* from which the *espinal* supposedly represents a regression. The evolution of the *espinal* is not clear, for early Spanish chroniclers described *espinales* as we see them today, and although the *espino* may have a greater ability to sprout after cutting than does *quillay* or *litre,* it was just as desired for firewood and as apt to be cut out as the latter two.

In certain areas of Coquimbo the *espinales* are being decimated, whereas in others they are increasing; in fact, the *espino* appears to be expanding into areas of cut-over and heavily grazed low sclerophyllous woodlands. Finally it should be pointed out that the seed of the *espino* remains viable over long periods, thus resembling mesquite (*Prosopis* sp.) and *Acacia constricta,* both invading and increasing in the American Southwest. The main difference, however, is one of cultural perception, because *espino,* desirable as firewood in Chile, is not considered a weed there, unlike its two counterparts in the American Southwest. On Fundo Camarico and in the area near San Pedro de Quiles where there is heavy grazing and woodcutting, one can see the encroachment of *Acacia caven* into areas previously covered by a scrub steppe. In corrals or fenced-off areas near the latter site, where goats or cattle are kept, numerous small *espinos* are encountered. It is difficult, however, to believe that many areas occupied by *espinales* in northern Coquimbo were ever covered by low sclerophyllous woodlands, although such speculation certainly deserves investigation. In some cases *espinales* are being destroyed but in other cases seem to be invading different plant communities. Those situations are not incongruous, however, for they probably represent different stages in degradation of vegetation or a series of different regressions in vegetal succession.

South from Cuesta el Espino to the Río Quilimarí the plant cover reflects an increase in precipitation. Because of degradation of the wild vegetation by man, however. the area from Auco to Illapel is quite barren in places. The dominant vegetation around Illapel, at least in areas not totally cleared, is similar to the scrub steppe already described for interior Coquimbo except for the appearance of more trees and mesophytic shrubs. Some of the prominent species around Illapel are listed in table 4.

In the spring the ground cover includes flowers common to the interior of the Province, such as *Argemone mexicana, Anemone decapetala, Clarkia* spp., *Tropaeolum* spp., *Moscharia pinnatifida, Pasithea caerulea,* and *Leucocoryne* spp. Around Illapel, years of woodcutting and overgrazing have eliminated most of the wild perennial vegetation. Along the river (Río Illapel) near Illapel, where once flourished a rich riparian vegetation containing numerous arborescent forms, only *Baccharis* spp. and *Pleocarphus revolutus* are now found in abundance.

South of Illapel near Caimanes the vegetation takes on the appearance of chaparral and is stratified into three stories, prominently including arborescent forms such as *Quillaja saponaria, Peumus boldus,* and *Cryptocarya alba.* The ubiquitous columnar cacti are still found, and *cardonales* of columnar cacti and *Flourensia thurifera* are conspicuous on north-facing exposures around Guanguali and Tilama. Encountered between Caimanes and Tilama are scattered patches of park landscape dominated by low sclerophyllous trees; similar parklike areas occur south of Illapel near Pupios. Those parklike areas, with gross physiognomic characteristics resembling the oak woodlands of southern Arizona, are usually found on south-facing exposures.

Other regions in the Province with park landscapes of low scattered trees are on seaward-facing slopes of the interior coastal ranges, such as around El Calabozo, near San Pedro de Quiles where a low woodland of *litre* is found, with scattered shrubs and a dense ground cover of herbs, and on the coastal plains and alluvial terraces near Tongoy where

there is a low wooded steppe or savanna with *guayacán* and *litre* the dominant arborescent forms.

The only region in Coquimbo with large stands of Chilean palms or *palmas chilenas* (*Jubaea chilensis*) is from Tilama south to Las Palmas, in Aconcagua Province. Palms were originally found in much larger numbers in the Province, and the northern border of their natural range was at the Río Limarí (Goodspeed, 1945, pp. 146-147; Cunill, 1971b). Now there are no large natural palm groves in the Province outside of the Tilama area except for a few palms in Quebrada las Palmas south of Mantos de Hornillo and some scattered palms in the coast ranges. Numerous Chilean palms have been planted throughout the Province, however, for decorative purposes. A toponymic study of 1:50,000 topographic maps of Coquimbo[15] shows numerous *quebradas* with the name *palmas*, although it is conjectural whether those names are derived from native palms that were cut out, or whether palms ever existed in those *quebradas*. The fruit of the Chilean palm or *coquito*, which is a little bigger than a walnut, has been an important trade export since the colonial period. The cutting-down of the palms to make *miel de palma*, a syrup made from palm sap, however, has contributed more than any other activity to the near-extinction of the Chilean palm in Coquimbo. Jiles, who as a child took the now-defunct railroad from Illapel to Cabildo by way of Tilama and Las Palmas, and who remembers that the palms were being exterminated in certain areas, feels that the palms are increasing today because of the enactment of strict protectionist laws (1971, personal communication).

Structurally, the vegetation of the lower slopes of the Andes in Coquimbo is quite similar to that described for the interior of the Province, although tending to be lower and more xerophytic. Hence, Schmithüsen (1956, p. 37) has appropriately named the vegetation of the precordillera *Zwergstrauch*, or dwarf shrub. Occasional thickets of *Larrea* or *Adesmia* are encountered on the dry slopes of the Andes, but trees and dense vegetal cover are usually confined to the sheltered areas.

Moving up the Río Turbio from Rivadavia, one is immediately impressed by the desiccation of the precordilleran vegetation. Near Huanta, about 1500 meters above sea level, *Prosopis chilensis*, *Acacia caven*, *Geoffroea decorticans*, *Schinus polygamus*, *Schinus molle*, and *Salix humboldtiana* are still encountered along the stream, whereas the large columnar cacti so abundant in coastal and interior Coquimbo thin out and eventually disappear. As altitudes increase, the numbers of shrubs on the slopes decrease. Found on the flanks of the valleys at 1800 meters are low dense brambles of *Adesmia* spp., *Proustia* spp., *Chuquiraga spinosa*, *Fabiana imbricata*, and *Baccharis rosmarinifolia*. Flourishing in humid places, especially along the streams, are *Cortaderia* spp., *Scirpus* spp., *Tessaria absinthioides*, *Baccharis pingraea*, *Baccharis confertiflora*, *Schinus polygamus*, and numerous *Escallonia arbuta*.

A situation analogous to that on the Río Turbio is met at similar elevations in the south along the headwaters of the Río Illapel. From Huintil to Carén, north-facing slopes of the precordillera support scattered *cardonales* of large columnar cacti and *Flourensia thurifera*, while the south-facing slopes support a scrub steppe containing most of the species described for the region near Illapel. Table 4 includes some of the most noticeable species growing along the streams and on the slopes between Huintil and Carén.

Between 1500 and 1800 meters the large cereus cacti begin to disappear and the vanguard of the high cordillera flora begins to appear: *Erigeron berterianus*, *Mulinum spinosum*, *Gymnophyton polycephalum*, *Tetraglochin* sp., *Ephedra andina*, *Buddleja gayana*, *Mutisia* spp., *Colliguaja* spp., and *Valeriana* sp. (Reiche, 1934, I, p. 295).

15. The topographic maps are published by Chile's Instituto Geográfico Militar in Santiago.

In general, the vegetal cover of the high Andes in Coquimbo is quite sparse for reasons not completely understood. Some Chilean scientists maintain that few perennial plants can survive the long periods of moisture stress in the Andes, pointing out that the winter snows are insufficient for high cordilleran vegetation and that moisture for plants in the high Andes exists only during the period of snow melt in the spring and early summer, before the long period of summer drought (Hernández, 1970, pp. 122-123). That explanation is unsatisfying, however. For example, the summits of the San Gabriel and San Bernardino mountains in southern California are quite similar in climate to the Andes, yet they have heavy forests directly dependent on winter snowfall for moisture. The vegetal poverty of the high Andes appears to be linked to the lack of a well-developed temperate flora in the floristic evolution of South America or to some other as yet unexplained phenomenon.

For a description of the high Andean vegetation, let us return to a description of the vegetation above 1800 meters along the Río Turbio and the Río Illapel. At 2150 meters and above, some 55 kilometers east of Huanta, widely dispersed spherical or globular shrubs one to two meters in height are encountered on the slopes. Two species dominate: *Gymnophyton robustum* and *Adesmia aphylla.* Scattered along the streams are *Baccharis* spp., *Cortaderia speciosa, Ephedra andina,* and *Escallonia arbuta.* Above 2800 meters, the slopes are populated by scattered low brambles of *Ephedra andina, Fabiana* sp. and *Tetraglochin* sp., and along the streams are *Fabiana imbricata* and some cushion or pillow plants such as *Acaena* spp., *Berberis empetrifolia, Mulinum spinosum, Cryptantha* spp. (Reiche, 1934, I, p. 283). Where the supply of water is constant in the summers, around lagoons or in marshes (*vegas*), a dense ground cover flourishes that is dominated by Cyperaceae (*Scirpus* spp., *Eleocharis* spp., and *Carex* spp.), Juncaceae (*Juncus* spp., *Potosia* spp., and *Luzula* spp.), and members of the genera *Werneria, Hypsela, Gentiana, Mimulus,* and *Epilobium.* The *vegas* form summer pastures of great economic importance in Coquimbo and, together with the woody perennials used for firewood, constitute the major vegetal resources for man in the high Andes. At 4300 meters the upper limit of vegetation is reached along the headwaters of the Río Turbio.

Along the Río Illapel, the flora of the high cordillera begins around 1800 meters with the appearance of communities dominated by *Ephedra andina, Nardophyllum* sp., *Chuquiraga* spp., *Adesmia* spp., *Viviana rosea, Haplopappus* sp., and *Fabiana imbricata.* Above 2600 meters the vegetation becomes sparse, and the upper limit of vegetation is finally reached between 3100 and 3500 meters. The *vegas* along the upper tributaries of the Río Illapel consist basically of the same species found in the *vegas* along the headwaters of the Río Turbio.

The vegetation is generally more luxuriant in coastal Coquimbo than in any other part of the Province, because of the high incidence of cloudiness, constant fogs, and fog precipitation on the coast. Precipitation increases from north to south are manifested in the vegetation. Even so, the large differences in relief cause generally greater changes in the vegetal cover from west to east, than from north to south. South of Agua Amarilla, the coastal vegetation becomes quite dense, and during the spring the ground has a continuous cover of annuals. A dense cactus scrub steppe (*jaral*) is encountered from the northern border of Coquimbo, south along the coast to La Serena. The perennial shrubs are larger and form a denser ground cover near the coast than in the interior. Table 4 lists some of the prominent shrubs and cacti near Choros Bajos in north coastal Coquimbo.

The vegetation in the mountains surrounding Choros Bajos is quite dense in some places, forming almost impassable thickets. If there have been winter rains, the herbaceous cover is incredibly beautiful in the spring. In the summer the picture of the coastal *jaral* around

Choros Bajos is dull and monotonous. In many years the droughts are so severe that many of the perennials die out.

Near the mouth of Quebrada los Choros are backwater lagoons around which *Salicornia peruviana, Cotula* sp., *Frankenia* sp., *Distichlis* spp., and other plants tolerating saline conditions are found. *Typha angustifolia* and *Phragmites communis* grow in the lagoons themselves.

Before the major man-induced disturbances in the wild vegetal cover, the vegetation around La Serena was probably much like that described for Choros Bajos except for being a little more mesophytic because of the greater precipitation at La Serena than at the other site. Since La Serena is near the mouth of the perennially flowing Río Elqui, there is a dense, swampy, riparian vegetation north of the city. The indigenous trees have been cut out, however, and replaced by exotics. The vegetation on the slopes around La Serena probably looked much like the *jaral-matorral* encountered on the interfluves between Quebrada de Talca and Quebrada de Arrayanes some twelve miles east of the city. This *jaral-matorral* contains many of the cacti and shrubs listed for Choros Bajos (see table 4). A vegetation similar to that described for Quebrada de Talca, though with more cacti and *Oxalis gigantea*, continues from Lengua de Vaca south along the coastal-facing slopes of the Altos de Talinay at low elevations to the mouth of the Río Limarí. On the low-lying coastal plains and terraces between Guanaqueros and Lengua de Vaca, one encounters a low woodland steppe, dominated by scattered low *litre* (*Lithraea caustica*) and *guayacán* (*Porlieria chilensis*), although numerous other arborescent forms are encountered, especially in the *quebradas*. In fact, the largest *litre* and *guayacán* in the Province are found in the Tongoy area, especially on Hacienda Tangue and around Pachingo, where the cutting of trees has been prohibited for some years. Table 4 lists some of the scattered bushes growing among the trees on the *litre-guayacán* steppe near Tongoy. The ground is covered by many of the exotic and endemic herbs already mentioned for the Province. The following species stand out: *Atriplex semibaccata, Anthochloa* spp., *Bromus* spp., *Festuca* spp., *Erodium cicutarium, Erodium moschatum, Stipa* spp., *Avena barbata*, and *Avena fatua*.

In the *quebradas* near Hacienda Tangue and Pachingo are found large *Geoffroea decorticans, Porlieria chilensis, Lithraea caustica, Prosopis chilensis, Cordia decandra, Maytenus boaria, Acacia caven*, and *Schinus molle*.

Moving south along the coast, more and more mesophytic plants are encountered and shrub size and density tend to increase. Large sections of the coast, however, have been cleared for dry farming (*lluvias*). Marine influences which tend to preserve soil moisture allow farming by *lluvias* to penetrate furthest north in Coquimbo along the coast. Historically, farming by *lluvias* has been carried on along the coast of Coquimbo as far north as La Serena, although instances of dry farming near Choros Bajos have been reported during extremely wet years.

At the national parks of Fray Jorge, Talinay, and Punta del Viento in the Altos de Talinay, patches of cloud forest are encountered in an area surrounded by xerophytic scrub. These cloud or fog forests consist of species similar to those found in the humid selva of southern Chile (see plate 3). The forests are remnants of extensive forests, now cut out, that during historic times occupied the seaward-facing summits of the coast ranges at elevations superior to 460 meters from Pichidangui to Lengua de Vaca. Table 4 lists the main plant constituents of the cloud forests at Fray Jorge and Talinay.[16]

Muñoz Pizarro and Pisano Valdés (1947) consider those forests to be relicts of extensive wooded areas that migrated northward under humid conditions in preglacial times, when Coquimbo was supposedly wetter and cooler than at present. They hold that these relict

16. See Muñoz Pizarro and Pisano Valdés (1947) for a complete taxonomy of the vegetation of the forests of Fray Jorge and Talinay.

forests are maintained in their present locations by particularly favorable microclimatic conditions. The contention of Muñoz Pizarro and Pisano Valdés, as well as other noteworthy botanists,[17] that the cloud forests in the Altos de Talinay are relicts is questioned, however, by Sparre (1956, pp. 39-40). Sparre believes that as more botanical evidence is gathered in the coastal mountains in north-central Chile many species now known at Talinay and Fray Jorge will be found in numerous places in the coast ranges, and that the distances between species will not be disjunct enough to classify the vegetation of those two forests as relict.

Campesinos frequently state that forests similar to those at Fray Jorge and Talinay once existed on Cerro Gran Naranjo southeast of Talinay and in the high coastal peaks behind Caleta Oscuro and Huentelauquén. This type of information is highly conjectural, however, and the *campesinos*' perceptions of what certain areas looked like in the past may be quite colored by the "good-old-days" fallacy, in which the past invariably looks better than the present (Hastings, 1959, pp. 25-26). My feelings are that the present forests of Talinay and Fray Jorge are remnants of forests that once covered extensive areas on some of the high summits of the coast ranges in historic times but were cut out until only the present remnants were protected in 1945 (Punta del Viento in 1967).

Jiles (1963, p. 5) remarks on cloud forests in Quebrada de Camarones (near Tongoy), Quebrada de Juan Soldado (north of La Serena), and Quebrada de las Amolanas. He has recorded similar forests also at Agua Amarilla, Chigualoco, and on the peaks of Santa Inés, La Silla del Gobernador, and El Boldo near Pichidangui.

As one proceeds south along the coast from the Río Limarí, the vegetation becomes more mesophytic. However, a large area embracing a rough rectangle from the Llanos de Cerillos, east to Ovalle, south to Punitaqui, and southwest to Bahía Teniente has been heavily cleared for *lluvias,* and the vegetation is quite impoverished. Encountered around Halcones and in other areas south along the coast are nearly pure stands of *chagual* or *cardón* (*Puya* spp.). *Puya* seems to be especially prevalent on well-drained soils in the area of Bahía Teniente; in some places it may represent a pioneer species. The *Puya* are much maligned by sheepmen because the sheep lose large quantities of wool on the plant's bladelike serrated leaves. Despite an attempt to develop a fiber industry using *Puya* fibers at Los Vilos, no serious harvest of the plant has yet occurred.

Between Bahía Teniente and Caleta Oscuro the vegetal cover begins to take on the appearance of the coastal scrub and chaparral communities of California. South of a point midway between Bahía Teniente and Caleta Oscuro, the vegetation on the seaward-facing slopes of the coast ranges forms a continuous cover when seen from a distance, almost smooth, with small trees frequently rising above the shrubby cover.

Between Huentelauquén and Agua Amarilla, the land is heavily disturbed from clearing and livestock utilization. In general, the main pioneer shrubs in cleared fields in coastal Coquimbo are *Gutierrezia paniculata, Haplopappus foliosus, Bahia ambrosioides, Baccharis concava, Ophryosporus triangularis, Pleocarphus revolutus,* and *Flourensia thurifera,* although the last two are encountered more often in interior locations. South of Huentelauquén, the columnar cacti are no longer a dominant feature of the coastal *matorral* and are found in abundance only on dry exposures. Scattered along the coast, near the Pan-American Highway between Caleta Nague and Agua Amarilla, are some dense thickets (see table 4) which are frequently, though erroneously, referred to as cloud forests. On close examination, however, one sees that those so-called cloud forests are growing around springs and in marshy areas. It is in such swampy thickets that the bones of a mastodon were discovered in 1899 (Reiche, 1934, I, p. 292).

17. The origins of the cloud forests at Fray Jorge and Talinay are discussed also by Hoffmann (1961), Follmann and Weisser (1966), and Galdames (1968).

Table 4 lists some of the dominant species in the coastal *matorral* near Los Vilos. There is a definite *krummholz* effect on the vegetation in that area because of the strong winds which blow off the sea, predominantly from the southwest. Much of the dense vegetation from Los Vilos to Quilimarí occurs around stacks and in *quebradas,* or in other areas difficult to clear for crops. In the spring, the ground is covered with a variety of flowering herbs. Some of the most conspicuous are *Leucocoryne purpurea, Hippeastrum bicolor, Alstroemeria* spp., *Pasithea caerulea, Viola asterias,* and *Calandrinia* spp.

The Cordillera de la Costa, which parallels the coast in southern Coquimbo, has a coastal chaparral cover composed of species similar to those already described for Los Vilos. Many of the summits of the coast ranges are constantly shrouded by dense fog (*camanchaca*). Increased moisture due to the *camanchaca* supports an extremely dense chaparral and some arborescent thickets similar to those at Fray Jorge in the southern coast ranges. Some of the woody thickets in the coast ranges south of Caleta Oscuro have trees that reach ten to twelve meters. Patches of such trees and shrubs are usually encountered on the highest peaks, in *quebradas,* or at points sheltered from the dry winds from the south. See table 4 for some of the prominent species in those woody thickets.

South from Los Vilos to Pichidangui, *chaguales* of *Puya* spp. are once again encountered in abundance and are sometimes present without any shrubby vegetation accompanying them. Where coastal chaparral is found, it consists of the species already mentioned for Los Vilos (see table 4). In the bottoms of the deep *quebradas* in this region, there is an opulent woody vegetation (see table 4). In summer, however, the herbs are dried and gone, and only the bottoms of the *quebradas* preserve their verdure.

A number of wild plants in Coquimbo are faced with extinction because of the activities of man. According to Muñoz Pizarro (1973), some of the species in Coquimbo in danger of extinction are *pacúl* (*Krameria cistoidea*), *palo gordo* (*Carica chilensis*), *algarrobilla* (*Balsamocarpon brevifolium*), *tara* (*Caesalpinia spinosa*), and the *palma chilena* (*Jubaea chilensis*).

Man has played a manifold and profound role in the evolution of the wild vegetation of Coquimbo, and the present vegetation cover is as much a measure of human influences as it is of physical environment. Man has had a brutal effect on the wild vegetation, leading to a badly degraded vegetational landscape in most of the Province. Indeed, the mismanagement of the Province's wild plant resources has contributed to microclimatic changes, the regression of wild vegetation, and the invasion and increase of xerophytes.

Historically, changes in the perception of the land and its resources, as manifest in the use of the land, have resulted in a succession of different types of wild vegetation. This is a consequence of the introduction of cattle, goats, burros, and other livestock; the elimination of wildlife; the intentional and accidental introduction of plants; the development of agriculture and the clearing of land for crops; the continuous cutting of the wild vegetation for fuel; the selective elimination of certain plant species by commercial and domestic gathering; and a number of other human activities.

SOILS

Even the most uninterested traveler passing through Coquimbo cannot help but be impressed by the frequently ravaged and desolate aspect of the landscape, a testament to the destructive influences of man on the land. The effects of rill, gully, and sheet erosion pervade the upland portions of Coquimbo. In areas cleared for dry farming for two years or more, the *campesino* has been farming subsoil, since the top soil has already been removed. Soil erosion and declining vegetation cover in Coquimbo are complementary processes.

Aside from the alluvial deposits of the major irrigated valleys of Coquimbo, the soils of the Province are very little known as to nature and characteristics. Most of the commercial crops raised in the Province are grown in the major river valleys because they are the only areas where good soils and water for irrigation are coexistent. Other than the alluvial soils of the irrigated valleys, however, the soils of Coquimbo are exclusively skeletal.

Zonal soils are rare in the Province and appear to be relicts of a past geological period when greater rainfall and warmer temperatures existed. Some fairly extensive areas of mature red soils occur in the coastal portions of the Province and on the Limarí plain near Ovalle, though their origins are not clear. Paskoff (1970, p. 329) and di Castri (1968, pp. 6 and 27) believe that those soils are paleo-soils, whereas others believe them to be the results of high humidity and fog precipitation. My impressions are that the red soils are of ancient formation and that the latter explanation for their origin is not plausible.

Zonal brown soils, having an A horizon rich in humus, are also encountered in parts of Coquimbo. It is doubtful, however, that those soils developed under the vegetal cover of widely spaced low xerophytic shrubs with which they are so frequently associated. Instead, they probably represent soils that developed under a chaparral or woodland steppe-type community that has been cut out by man. They may also reflect a forest-type cover that developed under a different climate in the past.

Virtually every degree of intensity of soil erosion can be found in Coquimbo, ranging from ravaged mountain slopes to barren plains. Removal of the plant cover of much of Coquimbo by man's activities has exposed large areas to accelerated erosion, completely removing soils that have taken millennia to develop. Some areas are so degraded that the soil fails to support even perennial weedy growth, and the prospect seems remote that a native plant community can regenerate itself in such areas in the foreseeable future.

FAUNA

There have been no studies of the ecological relations between man and the indigenous fauna and wild vegetation of Coquimbo. There seems to have been, at least in the last thousand years, a dearth of large herbivores, if not of large mammals, in Coquimbo. The *huemul* (*Hippocamelus bisulcus*), a large deerlike animal which is extinct in central and northern Chile, occurred in Coquimbo possibly as late as four hundred years ago (Iribarren, 1972, personal communication). Another herbivore, the guanaco (*Llama guanicoe*), an American cameloid, is presently found in the high Andes and in the mountains behind Choros Bajos, on the coast. It once had a wide distribution in the Province but has been hunted out for meat.

Little osteological work has been done with the remains of animals found in prehistoric archeological sites in Coquimbo; hence, information on the distribution of guanacos or *huemules* in Coquimbo cannot be extrapolated from archaeological data. Furthermore, there have been few attempts to identify the remains of birds, rodents, or other vertebrates found in archaeological sites, or to speculate on their ecological relations with man. Since some birds and rodents inhabit rather confined niches, their identification at certain sites in the Province might enable us to reconstruct the former vegetation cover of the areas.

Several of the vertebrates and invertebrates that occur in the Province are faced with extinction because of biological disequilibrium brought about by habitat destruction by man. Likewise, large numbers of animals are relatively more susceptible to hunting pressure than others because, as is the case with the chinchilla (*Chinchilla chinchilla*) and the fox (*Dusicyon* spp.), they are prized for their fur; or because, like the guanaco, they are prized

for their meat. These and other species have been hunted to near extinction. The chinchilla, which once inhabited an extensive area between the Atacama Desert and the Río Choapa, was nearly exterminated near the turn of the century because his handsome pelt was in demand for export to furriers in the United States and Europe. Today, the chinchilla is found in only a few isolated places in the high Andes of Coquimbo. The condor (*Vultur gryphus*), fox, and various cats have been heavily decimated because of their predatory effect on livestock, though there is some question whether the condor, lacking the talons of a bird of prey, is indeed a predator.

In summary, Coquimbo is poor in native vertebrate fauna, especially large herbivores, and a number of animals are extinct. Also, so little is known about the native fauna of the Province that little can be said about their ecology.

This chapter has described the physical environment in which man has acted out his systems of living on the land in Coquimbo. Subsequent chapters will trace the history of human occupation in Coquimbo; define and analyze the activities of man which have affected the wild flora; and consider how the future growth and welfare of the Province will be shaped by the ecological consequences of man's mismanagement of the wild vegetation.

3

HISTORY OF HUMAN OCCUPATION

Because culture history and cultural ecology are inseparable in understanding the historical ecological relations between man and wild vegetation, this chapter examines the history of human occupation and land tenure in Coquimbo from the advent of man in the region, some 10,000 years ago, and briefly assesses the impact of each major historical cultural sequence on the evolution of the wild landscape. Also included is a section on the *campesino*'s lifestyle and perception of the land.

THE ABORIGINES AND THE LAND

Despite major advances in unraveling the prehistory of north-central Chile in the last thirty years, the archaeology of the region is little known. That man has been in Coquimbo at least 10,000 years is substantiated by the discovery of bone and stone tools associated with extinct fauna near Laguna Tagua Tagua, placing man's occupation of central Chile at 11,380 ± 320 years ago (Montané, 1968, pp. 1137-1138; 1967, pp. 165-166). Because of the rudimentary state of archaeological knowledge concerning the prehistoric inhabitants of Chile, no firmly established chronology of prehistoric cultures has been forthcoming. The numerous chronologies proposed are mutually contradictory and in need of constant reassessment.

Subsequent to the so-called South American Hunting Tradition, with its emphasis on hunting Pleistocene megafauna, two traditions have been assigned by Willey (1971, pp. 202-213) to the prehistoric cultures of Chile: the Pacific Littoral Tradition (4200-500 B.C.) and the Andean Hunting and Collecting Tradition (7000-500 B.C.). The existence of two separate economic traditions in Coquimbo over long periods is doubtful, however, because of the ease of access along the major transverse valleys and the variety of ecological niches available over short distances. More than likely, peoples inhabiting Coquimbo in prehistoric times used all kinds of resources and moved along the major rivers from the sea to the cordilleras as the seasons changed.

According to Willey (1971, pp. 208-209), the Pacific Littoral Tradition is best represented in Coquimbo by the early-man site at Guanaqueros, on the Bay of Tongoy.[1] That site is an extensive shell midden, with several large burial areas and an artifact assemblage

1. For more information on the excavations at Guanaqueros, see Iribarren (1950) and Schiappacasse and Niemeyer (1964).

pointing to a people who were predominantly fishermen and shellfish collectors but also hunted land animals and collected wild plant foods. Guanaqueros-type sites have been found at numerous places in coastal Coquimbo, and the earliest peoples identified with those sites have been collectively designated as the *cultura de anzuelos de concha,* or the shell fishhook culture (Iribarren, 1969, pp. 156-157). Those peoples, like their immediate successors, utilized fish, shellfish, sea mammals, and algae in their diets.[2] Found in conjunction with Guanaqueros-type sites are *piedras de tacitas,* circular depressions that have been ground into large boulders. Just what these *tacitas* were used for is unknown, although they are presumed to have been used in grinding seeds. Archaeological evidence showing the grinding of certain wild plant seeds or fruits in these *tacitas* might allow us to speculate on the past vegetation cover of the area where the mortar holes are found.

Near the mouth of the Río Choapa, close to a Guanaqueros-type site, are found surface materials of the puzzling Huentelauquén complex which Mostny (1971) and Iribarren (1961) have identified as a culture. The Huentelauquén culture is tentatively thought to predate the Guanaqueros-type sites, and is associated with a strange artifact assemblage encountered throughout the entire length of Coquimbo, and beyond, from Carrizalillo, in the north, to Pichidangui, in the south. This artifact assemblage consists of some rather peculiarly shaped ground stone items which occur "as smooth-edge disks, cog-edge disks, and quadrangular, triangular, and polygonal (as many as twelve-sided) forms. They have been shaped from flattish pebbles or slabs of rocks and range from 5 to 12 centimeters in diameter and from 2 to 3 centimeters in thickness" (Willey, 1971, p. 209). Both Iribarren (1962, pp. 424-425), and Gajardo Tobar (1962-63, pp. 7-57) call attention to the similarity between these Huentelauquén geometric stones and the "cogged stones" of southern California. According to Iribarren (1969, pp. 154-156), members of the Huentelauquén culture hunted land and sea mammals as well as gathered wild plant foods and shellfish for sustenance.

Until the recent announcement of a carbon-14 date of 4700 B.P. for domesticated maize kernels at San Pedro Viejo (Rivera, n.d.), a site near Pichasca in the valley of the Río Hurtado, it was generally believed that domesticated plants first appeared in the Province around 300 or 400 B.C. Indeed, the earliest evidence for well-developed ceramics and agriculture in Coquimbo is found among bearers of the El Molle culture, around 200 or 300 A.D. According to radiocarbon dates, however, some early materials from El Molle culture may predate 250 B.C. (Iribarren, 1969, pp. 174-203). El Molle culture was originally discovered near the present town of El Molle, in the Elqui Valley, by Cornely (1956) in 1938. El Molle peoples inhabited all of Coquimbo north of the Río Choapa and occupied both coastal and interior sites in the Province. Those people were potters, agriculturists, hunters, metallurgists, and gatherers. *Piedras de tacitas* are also present at some El Molle sites. El Molle pottery seems to share characteristics with early wares found in the Atacama and northwest Argentina (Willey, 1971, pp. 216-217), and some late El Molle ceramics share features with the pre-Tiahuanacoid pottery styles of the Peruvian coast, such as the stirrup-spout and negative and resist-dye painting.

A new culture appeared around 1000 A.D. in the same portions of Coquimbo inhabited by members of El Molle culture. These peoples, also farmers, have been identified by

2. Sea algae such as *cochayuyo* (*Durvillea antarctica*) and *luche* (*Porphyra columbiana*); and shellfish such as *piures* (*Pyura chilensis*); *erizos* or sea urchins (*Loxechinus albus*); *locos* or the Chilean counterpart to the abalone in California (*Concholepas concholepas*); *choros* or mussels (*Choromytilus chorus*); *tacas* (*Protothaca thaca*); *almejas* or clams (*Ameghinomya antigua*); *machas* (*Mesodesma donacium*); *picorocos* (*Megabalanus psittacus*), which resemble large barnacles (CORFO, *Geografía económica,* 1967, pp. 292-297).

Latcham (1928) as *Diaguitas chilenas* because of their cultural similarities with Argentine Diaguita. *Diaguitas chilenas,* however, is an ethnic identification of an archaeological culture. According to Lothrop (1946, p. 633), when the Spaniards first entered Chile, under the command of Diego de Almagro in 1536, they had Indian guides (Diaguita?) with them from the present Argentine provinces of Catamarca and Jujuy who supposedly spoke the same tongue as the inhabitants of the Norte Chico. Also, Santa Cruz (1913), in his work on the aborigines of Chile, points out that many of the place-names in the Norte Chico are of Atacameño-Diaguita origin. Hidalgo (1971, p. 18), however, has found no ethnic identifications of the peoples of the Norte Chico in records of the early chroniclers, and it appears that the first Spanish *entradas* paid little attention to tribal distinctions or to the political organization of the aborigines in Coquimbo. One early chronicler, Bibar (1966, p. 41), states the unlikely proposition that the aborigines spoke different languages in separate valleys of the Province. At any rate, it may well be that the protohistoric inhabitants of the Norte Chico spoke Cacan or Diaguitan, like the Argentine Diaguita, but at the same time it should be emphasized that there are large cultural differences between the Chilean and Argentine Diaguita (Willey, 1971, p. 237). Although the *Diaguitas chilenas* seem to have been contemporaneous with El Molle for a short period, Chilean Diaguita usually takes up in the valleys where El Molle terminates, and it is unlikely that there was any appreciable lapse of time between them.

The *Diaguitas chilenas* appear to have entered the Norte Chico from the east with already well-developed agriculture. The Diaguita were primarily farmers and inhabited the major river valleys. They also practiced hunting and gathering and exploited shoreline resources like their El Molle predecessors. In addition to agriculture, they knew metallurgy,[3] weaving, and pottery-making. Their overall settlement pattern was dispersed, and individual houses were made of *pirca* stones or built entirely of reeds. That they came across the Andes from the east seems certain, for their pottery contains motifs of animals not native to Chile—jaguars and rheas. The date for Diaguita entry into Chile is still not substantiated archaeologically. Trade to the north appears to have resulted in cultural interchange between the Atacameño and the Diaguita. Furthermore, the Diaguita came into contact with Tiahuanaco culture, for they copied classical Tiahuanaco designs on their pottery (Lothrop, 1946, pp. 633-636).

Around 1471 or later, the Chilean Diaguita were conquered by the Incas, under Topa Inca, who by 1480 (?) had spread Inca domination throughout southern Bolivia, northwest Argentina, and northern and central Chile. In fact, it was by means of the main Inca road into Chile that the first Spaniards entered the Norte Chico. The Inca peoples, like their Spanish successors, were interested in the extraction of gold and silver, and Inca mining establishments have been identified in the Norte Chico (Iribarren *et al.,* 1962). When the Spaniards arrived in Chile, the Inca garrisons had already abandoned the country, although Inca colonies (*mitamaes*), inhabited by peoples from Arequipa and Lake Titicaca, were encountered along the Inca road through Coquimbo at Guamalata, La Chimba, and Sotaquí (Keller, 1955, pp. 39-40; Mostny, 1971, p. 154).

When the Spaniards first entered Coquimbo they found the aborigines (Diaguita?) concentrated in the major river valleys, where they practiced irrigated agriculture. The Indians probably dry-farmed the arid interfluves (Latcham, 1936, p. 14) when seasonal rainfall was much greater than normal, because the steep slopes of the interfluves are easier to clear than the floodplains. Irrigation was apparently little developed in the southern portions of Coquimbo, because annual precipitation was greater there.

3. The *maray,* a type of ore crusher, still employed by Chilean miners, was apparently used by the Indians of the Norte Chico in pre-Conquest times (Cornely, 1944, p. 38).

The Diaguita, although primarily agricultural peoples, were also fishermen, hunters, and wild-plant gatherers, and possibly herded llamas. Their agriculture was based predominantly on the following crop plants: maize, quinoa, potatoes, beans, squash, and chili. They appear to have had only two domesticated animals: the dog (*Canis domesticus*) and the llama (*Lama glama glama*).[4] Judging from the large number of indigenous wild plants utilized by the *campesino,* the aborigines must have made wide use of wild plant foods, although few of those have been identified from prehistoric sites. The aboriginal use of *algarrobo* (*Prosopis chilensis*) and *chañar* (*Geoffroea decorticans*) fruits is mentioned consistently in accounts of the early Spanish chroniclers (Bibar, 1966, p. 13; Mariño de Lovera, 1865, p. 27). The pods from the *Prosopis* were used to make a type of bread and an alcoholic beverage, while the fruits of the *chañar* were eaten in their natural state. Also, there is a tradition in the Elqui Valley as to aboriginal use of certain herbs to harden copper in the smelting process (Samatan, 1967, p. 126).

The last Chilean aborigines to preserve some degree of ethnic integrity into the present century in the Norte Chico were the Changos, all of whom had either died or were assimilated by 1930. Those peoples, littoral fishing folk, were not separate from the peoples encountered by the Spanish *entradas* in the interior, but they managed to hold on as cultural relics because they were not occupying lands that the Spaniards wanted (Iribarren and Montané, 1972, personal communication).

Estimates of the aboriginal population of the Norte Chico during the period of initial Spanish contact are extremely disparate, and the size of the prehistoric population will probably never be known. Oviedo y Valdés (1855, p. 268) states that the valleys of the Copiapó, Huasco, and Coquimbo had a total population of only 1500 when Almagro arrived, in 1536; Mariño de Lovera (1865, p. 41) claims that 8000 Indian warriors opposed the entry of Valdivia and his soldiers into the valley of the Copiapó. Bibar (1966, pp. 27, 29, 32, 34, 35) gives the following accounts of the aboriginal population of the Norte Chico in 1540:

1. The valley of the Copiapó has 1000 Indians.
2. The Huasco Valley has 800 Indians.
3. (The valley of Coquimbo): There were very many people and it was very populated, and when the Incas came to conquer them . . . over the opening of an irrigation canal which the Incas commanded them to make and they did not, [the Incas] killed more than 5000 Indians. . . .
4. The valley of the Limarí: In this valley there are few Indians.
5. The valleys of Choapa and Combarbalá are valleys that are not well-populated with Indians.

Since the figures presented above probably represent adult males or potential *encomendados,* a derived total population figure obtained by multiplying the above numbers by four or five members of a family would give a much greater population figure for the Norte Chico. Mariño de Lovera (1865, p. 79) arrived in Chile more than a decade after the Valdivia expedition but, unlike other early chroniclers, attempted to make an exact count of the total population, not just *encomendados.* He recorded a contact population for the Norte Chico of 20,000, which was reduced to fewer than 2000 by the 1590's. In 1545 Valdivia noted fewer than 3000 Indians between the Río Copiapó and the Río Aconcagua, and only 15,000 in the area between the former river and the Río Maule, with a decline already apparent.[5]

Such divergent estimates of the aboriginal population of the Norte Chico in the 1530's and 1540's are not easily reconciled. Hidalgo (1971, p. 55), who has gleaned the records of

4. Probably cavy (*Cavia porcellus*) and Muscovy duck (*Cairina moschata*) will come to be included as early domesticates as archaeological investigations progress in Coquimbo.

5. "Relación hecha por Pedro de Valdivia a Hernando Pizarro (1545)," in J.T. Medina (ed.) *Colección de documentos inéditos para la historia de Chile,* VIII (Santiago, 1895), pp. 82-98.

the early chroniclers, comes up with a figure of only 25,000 Indians for the Norte Chico in 1535. His estimate is quite similar to that recorded by Mariño de Lovera for the Copiapó, Huasco, Coquimbo, and Limarí valleys but includes the Choapa, Combarbalá, and Aconcagua valleys as well. A total aboriginal population for all the Norte Chico of 25,000 at Spanish contact does not seem very realistic; even a population of 100,000 could be dispersed over such a large area throughout the major river valleys and their tributaries without being impressive to the initial Spanish *entradas.* Such a low population figure might be plausible if the Inca conquest had heavily decimated the aboriginal population before the Spaniards arrived, or if disease had preceded the Spaniards into the Norte Chico. Another possible explanation for the low population encountered by the Spaniards in the north is that the Incas took captured peoples as porters and warriors (Montané, 1972, personal communication). Had there been a greater number of aborigines in Coquimbo when the Spaniards arrived, their numbers would surely have generated more interest in the region, because exploitation of Indian labor was necessary to the Spanish scheme of obtaining wealth in the New World. The population of Coquimbo at the arrival of the first Spaniards may never be known, and firmer estimates on the prehistoric population of Coquimbo will have to await future archaeological work in the Province.

Knowledge about the prehistoric inhabitants of Coquimbo is generally incomplete, lacking radiocarbon dates and systematic excavations. In general, scientists in Chile tend to minimize the impact of pre-Columbian peoples on the wild vegetation of north-central Chile. Although the total impact of aboriginal peoples on the wild vegetation of Coquimbo was probably minimal, aside from clearing and farming the floodplains of the major river valleys, nearly ten thousand or more years of prehistoric man's living on the land could not have helped but bring about changes in the composition and structure of the wild vegetation. The introduction of agriculture, the clearing of land, the cutting of wood for fuel, smelting and mining, the building of irrigation canals, the hunting of wild animals, the herding of llamas, the use of fire, and the selecting, gathering, and spreading of wild plants resulted in changes in the wild vegetation cover. Unfortunately, the nature, characteristics, and extent of these changes are difficult to measure.

After reviewing the contact ethnographies and archaeological materials on Coquimbo, I have concluded that, prehistorically, settlement was sparse and there were no large concentrated settlements in Coquimbo. It is also doubtful that the Indians used fire extensively for hunting or to clear land for agriculture. Undoubtedly, wildfires resulted from unattended campfires, especially in the chaparral communities of southern Coquimbo. Today, however, most comments on the aboriginal impact on the vegetation of Coquimbo must be highly speculative because of the poor state of archaeological knowledge of the region.

THE EARLY COLONIAL PERIOD AND THE FORMATION OF THE CULTURAL LANDSCAPE OF COQUIMBO (1536-1700)

Although Diego de Almagro entered Chile in 1536, effective Spanish colonization and settlement of this narrow strip of land west of the Andes did not begin until 1541, when Pedro de Valdivia founded Santiago, in the fertile Valle Central de Chile. Coquimbo was settled three years later, when La Serena, the present capital and administrative center of the Province, was established.

Semiarid north-central Chile presented the *conquistadores* with a physical environment very similar to the one they had left in southern Spain, and the Mediterranean crops and livestock which they brought with them survived and prospered with little difficulty. Wheat,

barley, alfalfa, olives, grapes, figs, and citrus fruit found conditions well suited in Coquimbo. More importantly, however, the Spaniards introduced institutions and perceptions of the land which, when blended with aboriginal cultural patterns, served as the basis for a whole new cultural landscape in Chile. This landscape (especially its rural components) has endured to the present with much of its colonial integrity. The perpetrator of this archaic colonial rural landscape in Coquimbo has been the *campesino,* who utilizes the land in much the same way as did his predecessors.

As must be apparent from the previous section on the aborigines and the land, the early Spanish chroniclers left very poor accounts not only of the Indians but of the vegetation cover of Coquimbo as well. These accounts give no evidence that Coquimbo was heavily forested when the Spaniards first arrived in Chile; indeed, the major vegetation types found in the Province today appear to be similar to those encountered by the first Spanish *entradas.*[6] Undoubtedly, whole vegetal communities have been both destroyed and created since the arrival of the Spaniards, and much land has been eroded by man's mismanagement of the Province's vegetal resources, but the concept that man has destroyed thousands of acres of forested lands in Coquimbo since the conquest is nonsense. Other than in the major river valleys and a few other areas heavily disturbed by man, the present wild vegetation of Coquimbo is similar in gross physiognomy to that encountered by the first Spaniards.

Since the Spanish *conquistadores* usually assessed the resources of the New World in terms of the number of aborigines available to be exploited in mining, agriculture, and other pursuits, the few Indians they found there left them less than enthusiastic about Coquimbo. As Pederson (1966, p. 47) so aptly states:

> To a significant degree, the Spanish conquest of the Americas was not so much a conquest of lands as it was a conquest of people—of people to be converted to the Christian faith, to be exploited in providing for the support and enrichment of the conquerors themselves, and to be put to work in producing those exportable commodities that would contribute to the wealth of Spain's merchants and Crown.

Since the principal source of wealth in Chile in the sixteenth century was gold, the need for Indians to work the gold placers (*lavaderos de oro*) and to raise crops to support the placer operations was met by concessions of Indians known as *encomiendas.*[7] The *encomiendas* were not grants of land but rights to services and tribute from Indians, conceded by the Crown for services rendered. The *encomendero,* or holder of an *encomienda,* was obligated to feed, clothe, protect, and proselytize the Indians entrusted to him; in return he had the right to exact tribute from his Indians, as well as service (Korth, 1968, p. 2). As is frequently noted in the literature of the period, the regulations of the *encomienda* were flagrantly violated, and the Indians were ruthlessly exploited for long periods in the *lavaderos de oro.* The aborigines were apparently treated as an expendable resource, and even though various ministers of the Crown attempted to cure the ills of the *encomienda* system in Chile, and numerous laws were passed to regulate the *encomendero*'s care of his charges, little appears to have been done to better the lot of the Indians.

Even so, the attrition of the native population in the placer gold mines in the first decades after the conquest has been exaggerated. First, it would make good economic sense to take care of one's Indian laborers, given the shortage of labor in the Province and the Spaniard's need for exploitable labor to accumulate wealth. Secondly, a study by Keller (1955, pp. 36-47) of the population of the Norte Chico in 1813 shows that large numbers of

6. A number of accounts give brief sketches of the wild vegetation of Coquimbo during the period of the first Spanish *entradas,* but among the best are Bibar (1966), and Mariño de Lovera (1865).

7. For an outstanding study of the *encomienda* in Chile, see Amunátegui Solar (1909).

Indians still occupied old *pueblos de indios*, or Indian villages, such as Algarrobito, San Isidro, Diaguitas, Peralillo, and other small settlements in the Elqui Valley in the early nineteenth century, long after most of the Indians were thought to have been annihilated or assimilated by their Spanish conquerors. Other Indian villages are noted in Coquimbo in the late eighteenth century at Sotaquí, Tres Cruces, Chalinga, Cuz-Cuz, and Guamalata (Amat y Junient, 1924, pp. 279-344; Santa Cruz, 1913, pp. 61-62). Nevertheless, literature detailing the maltreatment of Indians in the gold placers is conspicuous. Mariño de Lovera (1865, pp. 55-56) witnessed the indiscriminate impressment of men, women, and children to work in the placers. According to Pederson (1966, p. 56), the attrition of Indian labor in the placers correlates with the steady decline in gold production in the late sixteenth century. Negro slaves were soon imported, and Indians, mostly Araucanians, were brought from the south of Chile to work the placers of Coquimbo (Pederson, 1966, pp. 58-61).

Even the translocation of Indians from southern Chile and the introduction of Negro slaves seems to have done little to maintain preconquest population levels in Coquimbo; and, according to Pederson (1966, p. 61), it was not until the late eighteenth century that the preconquest population of the Norte Chico was finally surpassed. By then, however, Indians and Negros formed a low percentage of the total population, and a large *criollo* and *mestizo* population began to dominate (Keller, 1955). In 1720 the *encomienda* was abrogated in the New World, although it was not until 1791 that the practice was finally abolished in Chile (McBride, 1936, pp. 119-120).

The early Spanish population of Coquimbo had little interest in agriculture; their major concern was exploitation of the rich gold placers. Agriculture meant no more than subsistence, and was subordinate to mining. Not until the seventeenth century, when trade began with Peru, was there any significant shift to agriculture in Coquimbo.

Occupied first during the early decades of the conquest were the best agricultural lands of the Indians, although that practice was prohibited by the Laws of the Indies. Land grants (*mercedes de tierra*) were conceded to the Spaniards and *criollos* who had performed services in the conquest of Chile, or who were favored by the Crown. The *mercedes de tierra*, along with the *encomiendas*, were the foundation for the system of *latifundio*, which prevailed in Chile until recently. There are, however, several different types of *mercedes de tierra: solares*, or lots within city limits; *chacras*, or little farms near cities; *mercedes de labranza*, or major farms; *estancias de ganado*, or large cattle ranches; and finally *mercedes* of small parcels of land, along streams or in other locations, for setting up mills or ore grinders (*trapiches*) (Borde and Góngora, 1956, I, p. 30). *Mercedes de tierra* for large farming or cattle-raising operations were useless, however, unless they were close to an Indian village to which the owner also had *encomienda* rights over the aborigines, because the early Spanish conquerors had little intention of farming the land themselves. After 1575 the land grants were more homogeneous and their uses were no longer specified (Borde and Gongora, 1956, I, p. 36).

Because the *demora* (the period that the Indians were to work in the mines in Chile) was eight months in the early colonial period, large-scale cattle-raising developed in north-central Chile in order to feed the Indian mining gangs as well as to supply much-needed tallow and hides in mining operations (Góngora, 1970, p. 9). At the end of the sixteenth century there began a large export business in tallow, hides, *charqui* or dried meat, cordage, legumes, and mules to Peru (Keller, 1929, p. 276). Cattle roamed the mountainous interfluves of the major valleys unrestrained and were periodically rounded up by *huasos* (cowboys) for branding and slaughter. The fertile irrigated valleys were devoted to fields, vineyards, orchards and pastures.

Aside from placer mining for gold and the raising of cattle, probably the most significant economic activity in Coquimbo in the early seventeenth century was copper mining. The most important copper mines were near La Serena, and that provincial capital became the main supplier of copper for the artillery-makers at Callao and Lima (Pederson, 1966, pp. 69-74).

According to Carmagnani (1963, p. 33), the economy of the region between La Serena and Quillota during the first decades of the seventeenth century was based primarily on cattle and cattle products, and secondarily on copper. Placer mining for gold ceased being a dominant activity in the middle of the seventeenth century, and trade with Peru in tallow, hides, and copper made up the dominant economic activity in Coquimbo until the end of the seventeenth century, when Chile began to send wheat to Peru. The beginning of this interchange has been traditionally ascribed to the effects of a severe earthquake in Lima in 1687 which apparently caused severe damage to Lima's irrigation system, but the laws of comparative advantage seem to have been more important in bringing about this major qualitative change in Chilean agriculture during the colonial period.[8] There is little evidence, however, that Coquimbo enjoyed much of the prosperity from the ensuing boom in the trade of Chilean wheat to Peru. With the decline of the placer operations, and the growth of a market economy in tallow, hides, and wheat with Peru, the *encomenderos* moved their labor supply from the placers to agricultural pursuits.

The early colonial period in Coquimbo was characterized by the development of a completely new cultural landscape, whose basic rural components have lasted to the present. The introduction of European technology and systems of land tenure, together with Old World crops, livestock, and weeds, set the stage for vast changes in the structure and composition of the wild vegetation of Coquimbo. Few early chroniclers have left descriptions of the wild plant cover of the Province, but it is safe to assume that the initial impact of the Spaniards on the wild vegetation of Coquimbo was minimal. Only after the Spaniards turned to livestock raising and the growing of wheat for export to Peru, near the end of the seventeenth century, could the impact of Spanish occupation be significantly noticed in the wild vegetation. Certainly, the major river valleys of the Province were the first areas to feel the brunt of Spanish settlement, and the riparian forests around La Serena, where the Province's main smelting operations were located, must have suffered sizable damage because of the smelters' demands for wood for fuel. The systems of land use which were to structure the wild vegetation into the vegetational landscape witnessed today were well-implanted by the end of the seventeenth century.

THE EIGHTEENTH CENTURY AND CHILEAN INDEPENDENCE (1700-1818)

The eighteenth century in Coquimbo was characterized by the development of hard-rock mining, the rise of free and specialized labor, abolition of the *encomienda* system, growth of the copper industry, and increased trade in agricultural commodities to Peru.

As pointed out earlier in this chapter, the market for Chilean wheat in Peru opened in the late 1680's. Although most Chilean wheat bound for Lima during the eighteenth century was shipped from Concepción and Valparaíso, small amounts were shipped from the port of Coquimbo (Bauer, 1970, p. 145). The total acreage in wheat in Coquimbo was miniscule, however, and there is no evidence for large-scale clearing and dry-farming of the coastal terraces in the Province during that period. A list of exports from Coquimbo in 1704

8. For a good review of the history of the Chilean wheat industry and the opening of the Peruvian market for Chilean wheat in the late seventeenth century, see Sepúlveda (1959), and Bauer (1970).

inventories the following: chinchilla skins, butter, tallow, quartz, olives, wine, wool, hides, beer, goat cheese, *coquitos* (palm nuts), dried fruits, chili, *aguardiente,* barley, flour, potatoes, medicinal plants, *algarrobilla* (seed pods of the *Balsamocarpon brevifolium,* used for tannin), and ingots of gold, silver, and copper (Concha, 1871, pp. 189-190).

During the 1700's, Coquimbo enjoyed a boom in hard-rock mining, and numerous gold, silver, and copper mines were opened. New *asientos de minas* were established, and such mining centers as Combarbalá and Illapel gained prominence. Processing centers for the mines were usually established in the major valleys, where wood for smelting and water for grinding ores were available. Wood was the only fuel used for smelting in Coquimbo in the eighteenth century, and the cutting of the slow-growing trees and shrubs of the Province for smelter fuel had a devastating effect on the wild vegetation. In general, however, wood for smelter fuel did not become a critical problem in Coquimbo until the 1800's, when the expanding copper industry began to create local shortages of firewood, or *leña.* In many areas, especially where the terrain was rough and the local wood supplies for fuel were exhausted, mining had to be discontinued, even of ores having tenors above 50 per cent, because it was too expensive to haul ore to areas where it could be smelted (Schmidtmeyer, 1824, p. 256). Most transport during the eighteenth century in Coquimbo, one must remember, was done on the backs of mules and asses, and cart roads were almost nonexistent.

Agriculture in eighteenth-century Coquimbo prospered not only because of increased trade with Peru but because of increased national consumption. The expanding mining industry in northern Chile created new markets for agricultural products, and farming in the fertile irrigated valleys developed to meet the miner's demands for food, mules, tallow, hides, and forage.

According to the calculations of Keller (1955, p. 46), the area comprising the present Province of Coquimbo had no more than 22,000 people in 1778—slightly more than the aboriginal population reported for the area in the 1540's. With the nineteenth-century boom in copper and silver mining in Coquimbo, however, the population rocketed from 22,000 in 1788 to over 180,000 in 1885. Hence, the population of Coquimbo for nearly two and one-half centuries after the conquest remained stagnant, below the aboriginal population numbers. Since increased population, given the technical level of the *campesino,* would tend to intensify destruction of the wild vegetal resources, it is probably safe to assume (discounting alterations in the landscape due to woodcutting, browsing, and grazing) that destruction of the wild vegetation would be greater in the nineteenth century simply because of increased population pressure on the meager vegetal resources of the Province. Of course, the already devastating effects of overgrazing and woodcutting would merely be intensified in the nineteenth century.

The last century of Spanish control in Coquimbo, an expansive period, was characterized by a rapid increase in immigration, population growth, subdivision of the large landholdings in the valleys, the establishment of several new mining centers, and increased local and foreign trade in agricultural and mineral commodities.

The wild landscape was undoubtedly beginning to show the cumulative effect of over two centuries of Spanish occupation and largely uncontrolled exploitation of the natural resources. Wood for smelter fuel was in great demand during this period, with consumption increasing in direct proportion to the development of new copper and silver mines in the Province. Grazing and browsing on the slow-growing shrubs and perennial grasses had the cumulative effect of destroying the most palatable species. Woodcutting for smelter fuel had taken a heavy toll on the phreatophytic forests of *chañar* (*Geoffroea decorticans*), *algarrobo*

(*Prosopis chilensis*), and *espino* (*Acacia caven*) in northern Coquimbo, and entire vegetation communities were eliminated.

THE NINETEENTH CENTURY TO PRESENT (1818--)

On February 12, 1818, Chile officially declared her independence from Spain and opened her doors to foreign capital, technology, and markets, which had been forbidden by Spain. Under the protection of free trade, merchants from all over the world came to Chile to secure metals and agricultural products. By the middle of the nineteenth century, Chile became the world's leading copper producer (Miller and Singewald, 1919, p. 214) and one of the leading wheat exporters. Coquimbo was largely responsible for Chile's rise to the position of the world's number-one copper producer in 1876, and monies from the rich silver mines of the Province were of major significance to the national economy throughout the nineteenth century.

Probably the most extensive destruction of the wild shrubs and trees during any brief period in Coquimbo's history occurred after reverberatory furnaces were introduced for copper smelting, in the 1820's (Pederson, 1966, pp. 198-201). The cutting of trees and shrubs for smelter fuel completely denuded the wild vegetal cover around La Serena, and by 1840 wood for smelter fuel was so scarce that smelters in northern Coquimbo either had to import coal or shut down. Soon the bulk of the smelting in northern Coquimbo was being carried out at the ports of Guayacán, La Herradura, and Tongoy, where coal could be brought in cheaply from England and from Chile's coal mines at Lota, near Concepción.[9] By 1850 only southern Coquimbo had enough economically procurable wild vegetation left to support mining and smelting operations. After 1850, however, smelting with wood in the Province drastically declined, and before 1900 it had nearly disappeared.

During the nineteenth century, Chilean agriculture passed through two stages. The first stage, which ended around 1850, was a continuation of the colonial pastoral economy, with exports of tallow, hides, *charqui* (dried meat), wheat, wool, olives, and dried fruit. The second stage began with the opening of the large wheat markets in California and Australia in the 1850's, in response to the demand for foodstuffs caused by the gold rushes in those areas. The boom in wheat exports continued through the 1870's, when Great Britain began to import large quantities of Chilean wheat. Coquimbo indirectly enjoyed profits from the boom market for Chilean wheat but never became a large exporter herself since the bulk of the wheat was raised in the central and southern provinces. Nevertheless, large areas of wild vegetation, especially along the coast of the Province, were cleared for dry farming, and wheat from Coquimbo found its way to both foreign and domestic markets.

By the end of the nineteenth century, Chile lost its ability to compete with other large wheat-producing nations, and the Chilean wheat industry lapsed into a period of stagnation from which it never recovered (Bauer, 1970, p. 141). Chile was a marginal producer in a peripheral region and, except for a few years in the early 1900's, never again exported as much wheat as it had in the nineteenth century; indeed, after World War II, Chile began to import wheat. The wheat boom in Chile did not result in improved farm methods or in much capital investment in agriculture. Since land and labor were abundant, big property holders saw no need to invest in machinery and improved farm technology in a market that was likely to change overnight. Hence, when the world market fell and there was no large domestic market for wheat, the landowners did not rehire labor to raise wheat, but allowed

9. For information on the introduction of coal as smelter fuel in Coquimbo and the development of the smelters at Guayacán, Tongoy, and La Herradura, see Pederson (1966, pp. 202-208).

the abandoned wheat lands to return to fallow condition (Bauer, 1970, p. 221). Throughout Chile's history, however, agriculture has been inferior to mining as a source of economic wealth, and even during the boom years for Chilean wheat, agriculture exports seldom yielded more than one-tenth as much as the income derived from mining (Bauer, 1970, p. 173).

The prosperity which Coquimbo enjoyed during most of the nineteenth century came to an end in 1883, shortly before the termination of the War of the Pacific, when copper and silver production in the Province began to decline. The mining boom, which Coquimbo had previously enjoyed, shifted to the newly annexed provinces of Antofagasta and Tarapacá, and after the nineteenth century Coquimbo never again completely dominated the mining industry of Chile. Abandoned mine shafts, placer mines, and mining refuse piles, seen everywhere in the Province, attest to the historic significance of mining in Coquimbo. Mining is still an important activity although it does not dominate the income of Coquimbo as it did in the nineteenth century.

In 1885 the population of Coquimbo reached 189,700, a figure that was surpassed only once between 1885 and 1925 (see figure 3). After 1885, the population declined to 181,600 in 1895; then increased to 189,900 in 1907; and decreased once again, to 178,600 in 1920.[10] Migration to Antofagasta and Tarapacá undoubtedly accounts for much of Coquimbo's loss in population between 1885 and 1920. After 1925, when the population of Coquimbo again surpassed the 1885 mark, population continued to grow in small increments until a population of 336,821 was reached in 1970.[11] Most population growth subsequent to 1925 was dependent on the development of agriculture and greater economic diversity in the Province.

Despite inconsistencies in defining urban and rural populations, the census data from 1942 to 1960 indicate that the former has increased while the latter has decreased in Coquimbo.[12] Certainly, the decrease in rural population in many areas corresponds to increased land degradation and an inertness of technological level that allowed fewer *campesinos* to live off the land than was possible thirty years ago.

Since the 1930's, mining has become more diversified and agricultural production has enjoyed a better income ratio with mining than at earlier periods. Agriculture has not expanded as fast as population in Chile, however, leaving that country increasingly dependent upon imported food.[13] There are no simple explanations for the lack of consistent growth in the agricultural sector; they are many and varied, including conservatism of the *campesino,* land degradation, inefficient irrigation techniques, environmental hazards, and government policies tending to favor urban and industrial sectors over the rural economy. In particular, government price controls have tended to favor the urban consumer through controls designed to hold down the cost of food. In 1972 over $4 million worth of foodstuffs had to be imported, a large part of which could have been raised in Chile given improved systems of land tenure and agricultural price incentives. The slow agricultural growth is one of the most important factors affecting Chile's present economic and social development. In particular trouble is Coquimbo, which has so little arable land and is

10. Chile, Dirección de Estadística y Censos, *Población total por provincias, Chile: 1885-1960* (Santiago, 1964), p. 4.

11. Chile, ODEPA, Departamento Programación Grupo Estadística, "Población del país y por provincias a nivel comunal según censos de 1970 y 1960" (Santiago, 1971), p. 3. (Mimeographed.)

12. Chile, Dirección de Estadística y Censos, *Algunos resultados provinciales del XIII censo de población obtenidos por muestreo* (Santiago, 1963), pp. 123-124.

13. *Chile: Demand and Supply Projections for Agricultural Products, 1965-1980,* Economic Research Center, Catholic University of Chile (Santiago, 1969), pp. 1-2.

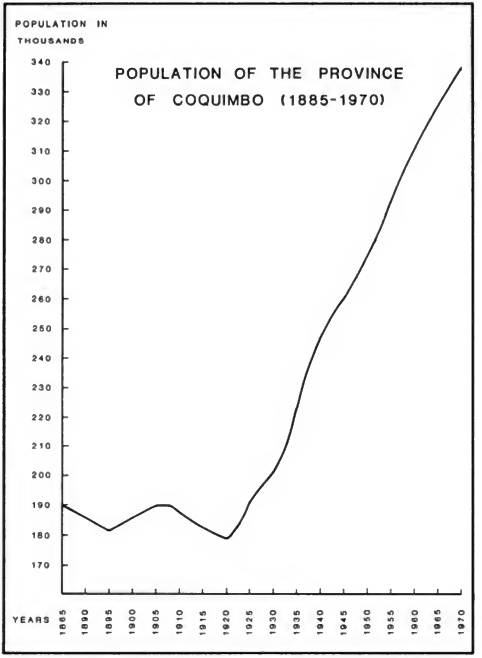


Fig. 3. Population of the Province of Coquimbo, Chile (1885-1970).

Source: Chile, Dirección de Estadística y Censos, *Población total por provincias, Chile: 1885-1960* (Santiago, 1964), p. 4; Chile, ODEPA, Departamento Programación Grupo Estadística, "Población del país y por provincias a nivel comunal según censos de 1970 y 1960" (Santiago, 1971), p. 3. (Mimeographed.)

destroying her vegetation and soils so rapidly. Recent government policies in Coquimbo (as in the rest of Chile) have attempted to increase agricultural production although seemingly with little success.

Coquimbo's future, like Chile's, depends on its natural resources. At this writing the land continues to be abused, and the Chilean government continues to emphasize production at the expense of conservation. Subsequent chapters will deal with land-use activities and the present state of the wild lands of Coquimbo.

LAND TENURE AND THE *CAMPESINO*

The *campesino,* whether an *inquilino, asentado, afuerino, arrendatario, mediero, comunero,* or the private owner of a small piece of property, perceives and utilizes the wild vegetation and other physical resources of his environment in the same manner, regardless of the system of land tenure of which he is a part. From childhood the *campesino* learns the merit of each wild plant in his surroundings and the ways in which it can be utilized. In Coquimbo, as in the rest of Chile, the traditional systems of land tenure are still fairly intact, although most large landholdings, or *fundos,* have been expropriated since the passing of new land-reform regulations in 1965. Even on the recently expropriated landholdings, however, there has been little change in traditional perceptions and uses of the land.

The structure of land holdings in Coquimbo consists of a small number of very large farms, a large number of very small farms, and a small number of parcels of communal land. Large and medium-size holdings held by a single family are called haciendas or *fundos* and comprise most of the arable land in the Province. Since the land reform acts of 1965, most of the large holdings have been expropriated and are now referred to as *asentamientos* or *centros de reforma agraria.* The small private farms, or *minifundios,* highly fragmented through generations of inheritors, are concentrated in the major irrigated valleys. Since most of these *minifundios* are too small to support even a small family, the owners must supplement their meager incomes by working on neighboring *fundos* or at other pursuits. Finally, the last system of land tenure to be considered is the large holding of communal land, or *comunidad.* The *comunidad* normally consists of both private and communal lands. The extreme land degradation encountered in all of these systems of land tenure is generally most pronounced on the *minifundios* and *comunidades.*

Many of the present social and economic problems of Chile have been traditionally ascribed to latifundium, or the holding of vast amounts of land by a few people. Most of these people, the landed gentry of Chile, have farmed their lands inefficiently, and the availability of cheap labor and the extensiveness of their landholdings have given them little incentive to invest in agricultural machinery, advanced technology, or conservation. On the other hand, the majority of the agrarian population in Chile lives in poverty, eking out a bare subsistence on intensely farmed and inefficiently irrigated small plots, or working as laborers on large *fundos.* In 1965, 61.8 per cent of the agricultural properties in Chile were under 10 hectares in size and accounted for only 1.4 per cent of the total agricultural land, while 1.3 per cent of the agricultural properties were 1000 hectares or more in size and accounted for 72.7 per cent of the agricultural land.[14] Hence one can appreciate the proportion of agricultural land in Chile that was in the hands of a few people.

The dichotomy between large and small land holdings is even greater in Coquimbo than in Chile as a whole, though we have to rely on outdated census data for that fact. In 1936, 8,806 (76 per cent) of the 11,573 agricultural properties in Coquimbo were under 5 hectares in size. There were 233 holdings over 100 hectares in size, and 104 holdings of over 5000 hectares.[15] In 1965, aside from the large sheep-raising provinces in Aisén and Magallanes, Coquimbo had the largest number of properties in Chile over 1000 hectares.[16] Hacienda Illapel (now Asentamiento Illapel) controlled over 150,000 hectares of land before it was

14. Cunill (1971a, p. 234) quoting Chile, Dirección de Estadística y Censos, *IV censo nacional agropecuario. Ano agrícola 1964-1965. Resumen del país. Cifras preliminares* (Santiago, 1966).

15. Chile, Dirección de Estadística y Censos, *Censo de agricultura 1935-1936* (Santiago, n.d.), p. 221.

16. Chile, Dirección de Estadística y Censos, *IV censo nacional agropecuario, Año agrícola 1964-1965, Resumen del país, Cifras preliminares* (Santiago, 1966), pp. 1-2.

expropriated by the government, in the late 1960's. McBride (1936, p. 127) notes that in the 1930's four *fundos* alone in the Comuna de Illapel held 316,000 hectares among them. As he points out, however, one must not be misled by these figures, especially in Coquimbo, for much of the land in these large properties is rough mountainous terrain totally unfit for agricultural use.

Until the recent advent of land reform, *fundos* or haciendas were ubiquitous in Coquimbo and controlled the bulk of the arable lands in the Province. The large *fundo* or hacienda was more than an extensive agricultural property; it was a society in itself, a society that acted as maintainer of many of the archaic colonial patterns of land tenure and land use that still persist in Coquimbo. The hacienda was an "entire system and governed the life of those attached to it from the cradle to the grave. It encompassed economics, politics, education, social activities," and indeed the culture of Chile (Thiesenhusen, 1966, p. 20).

Fundo labor has been traditionally composed of *inquilinos*, resident farm laborers; *afuerinos*, free laborers who work for wages; *medieros*, sharecroppers; and *arrendatarios*, tenants. The *inquilino* is given the use of a house and, usually, a small piece of land for planting his personal garden. In return for those and other benefits, the *inquilino* must usually work about six days a week for the *fundo* owner.

The next-most important system of land tenure in Coquimbo is the *pequeña propiedad, minifundio*, or small holding. Those holdings, usually of less than 5 hectares, account for 76 per cent or more of the property holdings in Coquimbo. In total, however, they account for a very small percentage of the arable land and are being continually fragmented through inheritance.[17] Being in most cases so small that they will not support a family, the owners usually have to work at mining or on the remaining large *fundos* to supplement their meager incomes. Almost all of the *minifundios* are concentrated in the irrigated valleys of the Province, and if the dry interfluves are not held in common by the *minifundistas*, they rent the land from *fundos, asentamientos*, and *comunidades* in order to pasture their goats and collect firewood. The interfluves, or the hillslopes near the valleys, are usually completely denuded of their perennial plant cover (except for a few species unpalatable to livestock) and are heavily eroded, having been exposed to continuous woodcutting, overgrazing, and clearing for dry farming, whereas the valleys are luxuriant in green verdure almost entirely exotic in origin. Another type of small holding is the *mediefundio*, a property varying from 10 hectares to 999 hectares (Cunill, 1971a, p. 236). The larger of these holdings is not very common. The medium-size holdings are usually the most economically sound properties in the Province.

The last major system of land tenure in Coquimbo is the *comunidad*, or communal property.[18] These communal holdings in Coquimbo apparently originated from old *mercedes de tierra* made to individuals in the sixteenth century. *Comunidades* are usually found on poor or marginal agricultural lands, and fathers, having little else to give their children, will titles to small plots of irrigated land in the valleys to each of their sons, while the hilly interfluves, because of their low carrying capacity, are used in common (see plate 5). This system of land tenure has persisted for centuries in Coquimbo, and hundreds (in some cases, thousands) of people on a *comunidad* can trace their lineage to the original receiver of the grant, in the 1600's. The institution of communal pastures, however, is old in Chile,

17. See Baraona, Aranda, and Santana (1961) for additional information on *minifundios* in central Chile.

18. For more information on *comunidades* and their origins, as well as their social and economic problems, see Cañon Valencia (1966), Huizer (1968), Garcia Jarpa (1970), Grebe and Unterrichter (1961), González M. (1951), Winnie (1965), and González del Río (1970).

appearing in the 1550's when grants to grazing rights were given (Borde and Góngora, 1956, 1, pp. 34-36, 67).

The *comunidades* are frequently studied because they cause the government economic and social problems due to title and boundary disputes, chronic poverty, unstable population, and degraded lands, but as a system of land tenure they are little understood. *Comunidades* are numerous in Coquimbo, especially in the *comunas* of Combarbalá, Punitaqui, Mincha, Paihuano, and La Serena. There are no exact data on the number of *comunidades* or *comuneros* (people who live on a *comunidad*) in Coquimbo, but there may be more than 150 such holdings in the Province and over 100,000 *comuneros*. If the data of some authors are correct, *comuneros* and their families make up 30 per cent of the total population of the Province. These people are the poorest inhabitants of Coquimbo, if not in all of Chile, and are constantly on the edge of poverty.

Some *comuneros* have legal titles to small irrigated garden plots in the major valleys or around springs in addition to rights to the use of communal lands on the dry interfluves. Their houses, like those of other small property holders in Coquimbo, are in the valleys, usually in ribbonlike settlements on alluvial terraces just above the cultivated fields, or in little clustered villages. Some *comuneros* have no rights to irrigated lands and depend for their living exclusively on the communal lands in combination with rented summer grazing rights in the *vegas* of the high Andes. They live primarily from herding goats, cutting firewood, charcoal burning, collecting salable wild plant products, or occasionally dry farming during infrequent wet years. The *comunidades* are not fenced (for that matter, few *fundos* have fences); and livestock, mostly goats, are allowed to pasture freely except for being excluded from cultivated fields by the herders. Transhumance is an essential pattern of animal husbandry in Coquimbo, and animals are taken from both *comunidades* and *fundos* in the summer to *veranadas* or summer pastures in the Andes.

Population is not only indigent on *comunidades* but varies greatly from year to year because of the marginality of the resources and the high density of population in relation to irrigated land. It is calculated, although the data are questionable, that *comuneros* possess only 5.58 per cent of the irrigated land in the Province (González del Río, 1970, p. 113). The irrigated holdings are obviously too small to support large numbers of *comuneros* and their families, so *comuneros* must rely heavily on work on neighboring *fundos*, goat-herding, woodcutting, mining, charcoal burning, and other pursuits. When the rains fail, as they often do in Coquimbo, most of the unirrigated croplands go unplanted; and the pastures, which are overstocked in wet years, have little or no herbaceous annual growth. The animals are usually unable to make the long drive to the Andean pastures in their weakened condition, and the goats and sheep die because the *comunero* has no money to hire trucks to move his animals to the *vegas* or to buy feed. The *comunero* then moves off the *comunidad* and seeks work in the mines or in service industries in the cities, awaiting word that the drought has ended so he can return to his home to rebuild his herd and to dry farm until another drought drives him from his land again.

Both the Chilean government and the United Nations have attempted economic development programs on some of the larger *comunidades*—Plan Punitaqui being an outstanding example (Garcia Jarpa, 1970)—but few of the programs have had any success. The government recently placed emphasis on bringing irrigation water to some of the largest *comunidades*, such as Punitaqui and Huentelauquén, through a system of canals leading from dams constructed in the interior of the Province. These dams have not yet filled the impoundment areas, however, and there are indications that runoff in the rivers of Coquimbo in most years may be insufficient even to fill them, let alone support large irrigation projects. Inefficient

irrigation, however, accounts for great water losses, and more efficient water use would undoubtedly lead to greatly expanded irrigated croplands in the Province. In the meantime, the *comunidades* are steadily losing population, and in many cases the land on the *comunidades* is so degraded that it is beyond reclamation under present technological levels (see plate 6). Considering Chile's limited capital, one wonders whether the monies presently spent to reclaim these badly denuded lands might be better used in other areas of the economy. Some have suggested that communal lands be seized by the State in order to allow the wild vegetation to regenerate, and the grazing be regulated to bring the degraded areas back into production.

Chile's population has grown faster in the last two decades than her ability to feed herself. This fact, plus the control until recently of the country's agricultural resources by a relatively small class of people, has given rise to land-reform programs as a means of increasing Chile's agricultural production. In the 1960's, various agrarian reform laws led eventually to expropriation of the large *fundos* by the government, in 1965. In 1973 most of the *fundos* with 40 or more hectares of irrigated land had been expropriated.[19]

The government adopted the *asentamiento* as a transitional system for managing expropriated estates during a three- to five-year period before the land is turned over to the *campesinos.* Representatives from the Corporación de Reforma Agraria and other government organizations, together with a committee elected by the *campesinos,* manage an expropriated *fundo* jointly during this period, with the objective of easing the transition, minimizing production losses, and preparing the *campesinos* to take over full management responsibilities. In theory the *campesinos* decide whether the expropriated land will be divided into individual holdings, operated collectively, or organized into a mixture of the two forms (Barraclough, 1970, pp. 225-226). In late 1971 the Allende government decided that the *asentamiento* program was not succeeding and replaced it with a new transitional system for newly expropriated holdings, called *centros de reforma agraria.* Agrarian reform laws allowed the government to impose cooperative ownership and operation if there were overriding reasons for doing so. Hence, there was some fear among certain segments of Chilean society that the *centros de reforma agraria* would eventually become state farms, and that such communal farms would take on the appearances of the *comunidades.*

The *asentamiento* system has not functioned as originally planned, for a number of reasons. The most important reason is that government officials simply took the place of the old *patrón* or *fundo* owner, and the *campesinos* then looked to the government officials to make decisions for them. Also, large numbers of people still remained landless under the *asentamiento* system, and hoped-for changes in agricultural technology and increased production did not materialize.

The profound problems facing Chilean agriculture are not within the scope of this work. Positive changes in Chilean agriculture will require more than simply changing the systems of land tenure, creating market incentives for agricultural products, or stimulating *campesinos* to want higher standards of living. It will require a basic change in the culture and life style of the *campesino.* The *campesino* probably knows less about farming than his old *patrón.* Most of the economic schemes for the agrarian sector are designed by city-oriented, urban-trained economists who do not understand the *campesino,* his perceptions of the land, or his way of living on the land. These economists are even less knowledgeable in geography, biology, and, more importantly, ecology; they place emphasis on production at the expense

19. Since the ouster of Allende's regime, many of these properties have been returned to the original owners.

of conservation, and continue to fail at the former. Indeed, the only places in Coquimbo where any conservation was practiced were on the *fundos.*

One cannot help but be skeptical about a land-reform program where few, if any, ecological studies have been done, or cadastral maps completed to establish property lines. In Coquimbo, as in the rest of Chile, the race between population and resources continues. The demand for more food is being met at a terrible price to the land, especially in Coquimbo, where land degradation is already advanced. Denuded hillsides, sparse crops, underfed livestock, roaming goats, and soil removal increase at expanding rates. The *campesino* in Coquimbo, on the other hand, does not see the destruction of the land so apparent to outsiders, nor does he desire the changes that some revolutionaries would like us to believe. Of course, *campesinos* desire more wealth and a better standard of living, but with few cultural sacrifices.

At this point in the investigation, a few brief comments seem in order on the life style of the *campesino.* The *campesino* is Catholic, strongly nationalistic, and closely tied to the regional economy of the Province. He appears to share national fashions, values, and aspirations, though he may be far behind the times in all these. He lives in a roughly built adobe or wattle and daub house; owns less than a hectare of irrigated land; and earns the bulk of his living from horticulture, mining, and goat herding. His farming techniques are generally primitive, and little or no animal or commercial fertilizer is used except on the *fundos* or *asentamientos.* Small garden plots are usually flood-irrigated by water from springs or irrigation canals, and losses of produce to insects and disease are normally large.

Although most *campesinos* are functionally illiterate, literacy is valued as an aid in social and economic improvement, and most rural peasants attempt to send their children to school. *Campesinos* have little in the way of technological facilities, and luxuries such as electric lights, gas stoves, modern plumbing, and motor vehicles are just beginning to reach rural areas.

Although some *comuneros* are of pure European descent, the majority of *campesinos* are a mixture of European and Indian ancestry. In general, except for those living near such villages as Cuz-Cuz, Chalinga, Sotaquí, El Molle, and Diaguitas (all formerly *pueblos de indios*) most *campesinos* have only a small percentage of Indian blood.

A *campesino*'s work day lasts from sunrise to sunset, with long hours spent on the daily chores of collecting firewood, obtaining water, preparing meals, doing laundry, etc. Environmental resources are so meager in many areas that tedious hours of intensive labor are needed just to produce a few vegetables or a few pounds of charcoal.

There is little capital surplus, and few *campesinos* have any material possessions aside from their house, their land, a few animals (mostly chickens and goats), some primitive farm implements, and a few homemade or cheap store-bought household goods. Parents usually have a strong desire to leave their children an inheritance, and in some cases the only family heirlooms may be a charcoal clothes iron or an old brass bed.

Infant mortality is high, but more from the lack of modern medicine and hygiene than from malnutrition, for few *campesinos* are starving. A typical breakfast is a piece of *pan amasado* (bread) and a cup of tea, while dinner and supper may be a *cazuela* (a soup made with vegetables and meat stock), a bowl of *porotos* (beans), or a thick soup of potatoes and semolina, served with *pan amasado*, goat cheese, fruit, and tea. Some *campesinos* fare badly, however, and one *comunero* visited by the author had nothing but a limited supply of tomatoes, goat cheese, squash, and cactus fruit to eat for several months at a time. At Choros Bajos, a *comunero* who had no rights to irrigated land, and whose goats died off in the drought of 1970-71, was supporting his family by collecting and drying shellfish (mostly

locos [*Concholepas concholepas*] and *lapas*, a type of limpet). Since he sold his starving burro to a lunchmeat manufacturer in La Serena, he would walk 25 kilometers to the fishing grounds. He would stay out for four or five days at a time collecting and drying shellfish, subsisting on stale bread, herb tea, and shellfish. He sold the dried *locos* in Choros Bajos and used the proceeds to buy flour, oil, beans, and other staples for his family. His young sons contributed to the family larder by surf-fishing for *corvina* (sea trout) and *lenguado* (halibut).

Most *campesinos* have a strong sense of responsibility to their families, and everyone in the family who is physically able works and contributes to the family's welfare. When a drought destroys the family's crops and livestock, the fathers and sons go to the mines or to the cities for employment, sending money home and awaiting news that the drought has ended, so that they can return home. Only under dire circumstances are young women allowed to seek work in cities, and then usually as maids. Considerable emphasis is placed on extended family relationships (*compadrazgo*) and labor reciprocity; these institutions not only offer the individual security but also tend to perpetuate the inertia and conservatism in the *campesino*'s life style.

A common characteristic of the *campesino* which colors not only his outlook toward life but his attitude toward the land, is his belief in the *dignidad de la persona*, or the dignity of the person. In other words, each person has an individual dignity, an inner worth, or role in life. Since that role is predestined, no shame is felt for what a person is, at least in terms of social class. This *dignidad de la persona* also manifests itself in the *campesino*'s sense of manliness, or *machismo*, and contributes in many other ways to his personality and his goals in life.

Campesinos are fatalistic, accepting droughts, crop failures, and disease as inevitable. If a peasant is crippled by polio he accepts his disease as a penance for a sin committed either by himself or by other members of his family. The *campesino*'s fatalistic approach, as well as his belief in the *dignidad de la persona*, results in acceptance of social inequality—an acceptance that the recent Chilean revolution was unable to overcome. The son of a *comunero* or an *inquilino* does not think he is personally or legally equal to the son of a *fundo* owner. The *fundo* owner or *patrón* is the master and decision-maker, and the *inquilino* the worker. On the other hand, a *campesino* believes he can rise in the social hierarchy if he has the *dignidad de la persona* to do so. There is no protestant work ethic among *campesinos*, because hard work, especially in this confining social and economic environment, does not necessarily result in material wealth or social advancement.

The *campesino*'s overall perception of the land and its resources varies little whether he is a *pirquinero* (an independent miner who works a vein or tailing, usually by himself or with another miner) or a *comunero*. He generally perceives the land as having an infinite ability to recover from abusive practices. In his eyes he is not destroying the land or its ability to be productive. Each generation should take from the land what it will yield, and if the yields are meager that was predestined. Today, however, *campesinos* are beginning to see their land changed into "deserts," and there is a hopelessness about their children's future and the ability of the land to recover.

Even on the poorest *comunidades* in the Province there is resistance to change, and economic development programs must be carefully designed to satisfy the tastes and technological capabilities of the *comuneros*. In general, government agents and economic planners who attempt to change traditional values or systems of land use are distrusted. The *campesino* does not believe that an outsider will ever know as much about the land or utilize it as efficiently as he or his forefathers. Nevertheless, most *campesinos* are fairly well

informed and are usually willing, especially when they are unemployed and hungry, to try what "educated" outsiders suggest. At the same time, they have a distrustful "wait and see" attitude which in a few circumstances has ruined what have appeared to be sound, well-designed community development projects. In some situations, the *campesinos*' distrust of community developers has been justified. In effect, the traditional life style of the *campesino* has limited innovation and change in much of rural Coquimbo.

This chapter has provided some insights into the sequence of human settlement in the Province of Coquimbo and the historical dimensions of human impact on the wild vegetation. For conservation and economic development programs to reverse the continuing deterioration of the wild vegetation and other natural resources of the Province, the Chilean government must understand the *campesino* and his culture, as well as his use of the land.

4

ENVIRONMENTALLY EXPLOITIVE TECHNIQUES

The present spatial arrangement, structure, and composition of the wild vegetation of Coquimbo mirrors the cumulative effects of centuries of man's impact on the land. With few exceptions, the principal land-use patterns which have influenced the wild vegetal cover were developed in the sixteenth century and have been perpetuated in the conservative culture of the *campesino.* Although these land-use activities are simple to define, each land-use pattern requires detailed examination because of the subtle feedback effects between each activity and the physical environment. Only then can a perspective be gained on the magnitude of each activity's impact on the vegetation. Unlike the situation in many other parts of the world, where the historical cultures that created a sequence of distinct landscapes have disappeared and particular knowledge of land-use activities has been lost, we have a viable cultural relic to study in Coquimbo–the *campesino.* That is to say, the system of land use of the *campesino* has changed little since the colonial period. This chapter defines and analyzes the major patterns of land use which have been instrumental in the evolution of the wild vegetation of Coquimbo.

THE COLLECTING OF MEDICINAL PLANTS

The introduction of antibiotics has had little effect on the gathering of wild plants for medicinal uses in Chile, and the use of medicinal plants seems as widespread today as it was in the past.[1] One seldom goes to a Chilean marketplace without seeing a herbalist selling a wide variety of bark, leaves, and roots for medicinal uses. Every Chilean, regardless of social class, uses medicinal plants, and it is not uncommon for a hostess at a very fashionable home in Santiago to offer her guests an after-dinner *aguita,* a cup of hot water to which a medicinal herb has been added to aid digestion. The guest can usually choose from five or more herbs. Before retiring or in the mornings, Chileans may combat various illnesses with medicinal teas made from the leaves, bark, or roots of more than a hundred wild plants.

1. For information on the different medicinal plants and their uses in Chile, see: Tadeo de los Reyes (1956), Urban (1934), Marzán (1935), "Un Sacerdote Salesiano" (1919), Goméz de Vidaurre (1889), Espinosa (1897, pp. 42-52), Murillo (1889), Guajardo (1892), Archivo Nacional de Chile, *Fundos Varios,* Vol. 245, Part 14; Petersen C. (1937), Reiche (1901), Jiles (1963, pp. 23-24), and Santa Cruz (1939).

Even the best drugstores in Santiago offer packages of medicinal herbs from all over Chile and the world. Although reliance on medicinal plants by members of the upper classes of Chile seems to be based more on tradition than on the unavailability of modern drugs, the *campesino* living in remote areas relies heavily on plant cures.

Not only does the *campesino* believe in the healing power of certain medicinal plants, but in many cases he shuns modern medical treatment in favor of the plant cures of the village healer, or *curandero*. Knowledge of the medicinal properties of plants and their uses is part of every *campesino*'s life. Indeed, most *campesinos* interviewed by the author knew the supposed medicinal values of at least 30 wild plants.

The tradition of using medicinal plants in Chile goes back to aboriginal times, and over the centuries hundreds of medicinal plants have been identified and recorded. The contemporary pharmacopoeia of medicinal plants in Chile exhibits a blending of aboriginally used endemics, cosmopolitans, and European adventives. Most of the plants having medicinal uses are dicotyledons, generally collected when flowering. According to the widespread doctrine of signatures, which can be traced back to certain medieval European traditions, each remedy for which a plant can be used can be noted by some mark on the plant or characteristic of its leaf structure. In other words, a plant with a heart-shaped leaf can be used for the heart, while a plant with a trilobate leaf might be used for the liver.

The roots, bark, or dried leaves of numerous medicinal plants have been collected at one time or another in Coquimbo for export. Most such have been exported also for other than medicinal reasons, although medicinal uses have been the specific reason for the export at one time or another of the bark of *canelo* (*Drimys winteri*), the leaves of *bailahuén* (*Haplopappus baylahuen*), the roots of *pangue* (*Gunnera chilensis*), the dried leaves of *boldo* (*Peumus boldus*), and other plants or parts thereof.

Some native wild plants with medicinal properties that are faced with extinction are *pacúl* (*Krameria cistoidea*) and *pangue* (*Gunnera chilensis*). Their depletion, however, has been due to uses other than medicinal ones. The only plants which are scarce because of collection solely for medicinal purposes are *bailahuén* (*Haplopappus baylahuen*) and *chachacoma* (*Senecio eriophyton*).

Since the vast majority of medicinal plants are adventives and grow in disturbed areas, they are generally readily abundant, and their abundance seems to be indicative of landscape degradation. Indeed, the number of endemic plants faced with extinction due to collecting for medicinal purposes is minuscule.

The collecting of wild plants for medicinal purposes seems to have had little effect on the wild vegetational landscape of Coquimbo, and this collecting activity is generally more of an indicator of the multiplicity of uses to which the *campesino* puts the wild vegetation of Coquimbo, rather than a source of primary disturbance in the vegetation. As a whole, the collecting of medicinal plants in Coquimbo is of far greater significance culturally and socially than in landscape modification. The collection of medicinal plants in Coquimbo is generally of significance only in conjunction with a number of other collecting activities which have had far-reaching effects on the evolution of the present structure and composition of the wild vegetation.

WOODCUTTING FOR FIREWOOD AND CHARCOAL

The traditional use of *leña* (firewood) and *carbón de leña* (charcoal) by rural Chileans for heating and cooking has been a salient cause for much of the degradation of the wild landscape in Coquimbo. Charcoal ovens and twisted and hacked tree trunks are common

sights in the Province (see plate 7). Presently, 70 per cent or more of Coquimbo's inhabitants satisfy their cooking and household heating needs with firewood and charcoal (CORFO, *Geografía económica*, 1967, p. 643). According to a statistical census for Coquimbo in 1941, over 30 per cent of the money spent for combustibles in the Province was for firewood and charcoal.[2] This figure is quite impressive when one realizes that the majority of *campesinos* still collect their own firewood today. Probably no single activity except goat grazing has had a more devastating effect on the vegetation of Coquimbo than the long history of continuous woodcutting.

Petroleum fuels have made few inroads on the traditional wood-gathering activities of the Chilean *campesino*. Even in Santiago, where cheap kerosene is available to operate gas heaters during the cold months, charcoal braziers are still used. In poor rural areas, such as Punitaqui and Peña Blanca, where local fuel supplies were exhausted decades ago, the *campesinos* are using dung and imported firewood for fuel. Firewood for most of the major cities and towns of Coquimbo is transported by truck from source areas at great distances from the concentrated settlements; even around small towns and villages, local wood supplies are exhausted, and woodcutters and charcoal burners have to travel many kilometers to collect firewood.

Probably the most extensive cutting of the slow-growing trees and shrubs of Coquimbo over short periods occurred in the late eighteenth and nineteenth centuries, when large amounts of firewood were used for smelting the rich copper ores of the Province. The miners not only cut large quantities of firewood for smelter fuel but kept large numbers of livestock, mostly goats, also contributing to destruction of the wild vegetation.

Around 1820, reverberatory furnaces were introduced in Coquimbo to smelt copper (Pederson, 1966, pp. 198-201), and the increased demands of these furnaces for fuel led to destruction of the plant cover near La Serena, Andacollo, Punitaqui, and other mining centers in the Province.[3] Indeed, the cutting of fuel for the reverberatory furnaces was in itself a form of mining, and wood continued to be mined for smelter fuel until that became economically unfeasible.

Until the twentieth century, all other economic activities in Coquimbo were subordinate to the interest of mining. Miners had rights (*servidumbres*) to water and fuel on either public or private land around mining claims; and in Coquimbo, as in the rest of northern Chile, there were numerous disputes between landowners and miners over these *servidumbres*.[4] These rights, contained in the Spanish "Ordenanzas de Minería," gave miners, according to Gay (1838, p. 2), "the right to tear out and destroy everything." Firewood was cut indiscriminately by miners, and few Chileans thought of the ecological consequences. Mining has always received priority in the use of natural resources in Chile, and regulations benefiting mining have generally voided regulations toward conservation.

In the 1840's wood for smelter fuel became so scarce in northern Coquimbo that coal had to be imported from the Lota mines, and by 1850 the coal-burning smelters at Tongoy,

2. Chile, Dirección General de Estadística de Chile, *Anuario estadístico de Chile: 1941, Agricultura e industrias agropecuarias, Año agrícola 1941-1942* (Santiago, n.d.), p. 10.

3. Of a number of accounts noting the destruction of the wild vegetation for smelter fuel in the Norte Chico during the nineteenth century, the most detailed are Gay (1838), Chouteau (1887), Larraín (1873), and Vicuña Mackenna (1856).

4. Archivo Nacional de Chile, *Archivo Judicial de La Serena*, File 4, Piece 6 (1840), "Iniciada el 17 de octubre de 1840 sobre el denuncio de un sitio i leñas para fundir metales, Demandante: Don Manuel Avrell; Demandado: Don Tadeo Cortés"; and *Capitanía General*, Vol. 251, "Año de 1793. Don José Monrreal sobre la libertad de cortar y salar leñas de qualesquier monte para fundir metales de cobre en el partido de Copiapó."

Guayacán, and La Herradura produced the bulk of Coquimbo's copper ingots (Pederson, 1966, pp. 198-201). By 1865 most smelting operations in northern Coquimbo were confined to the coast, and only in southern Coquimbo was there enough economically procurable vegetation left to support sizable smelting operations. Illapel and Combarbalá were so isolated from outside fuel sources that their smelters depended on local wood supplies until the early 1900's. In fact, as late as 1887 all smelting establishments in Illapel except two continued to smelt copper with firewood (Chouteau, 1887, p. 222). The smelting establishments in the Province which used wood for fuel were insignificant after 1850, however, when compared with the coal-burning smelters at Tongoy, Guayacán, and La Herradura. One smelting operation was still using firewood as late as 1910, in Aconcagua Province (Sundt, 1910, p. 16). After 1910, however, every important smelter in northern Chile had converted to coal.

Little information is available on the amounts of firewood consumed by the wood-burning smelters of Coquimbo. In the late 1860's it was noted that three reverberatory furnaces at Huintil on Hacienda Illapel had consumed 120,000 *cargas* of firewood (Chouteau, 1887, p. 218). Since each mule *carga* averages 160 kilograms in weight, upwards of 20,000 metric tons of firewood may have been consumed by those three ovens. One must realize not only that there were scores of blast furnaces using wood as fuel in Coquimbo in the nineteenth century, but also that the firewood for the smelters was cut not from dense forests but from chaparral and desert scrub-type communities.

Since high temperatures for a short period are needed to smelt copper, *leña blanca* (light, resinous wood) seems to have been preferred over harder woods.[5] Dry *leña blanca, porosa,* or *de la vega* has a greater inflammability than *leña compacta* (hardwood).

The effect of woodcutting for smelter fuel has been extreme in some areas, and the vegetation has never recovered. Cunill remarks that, in heavily cut-over sections around some of the eighteenth- and nineteenth-century smelting establishments, soil types which once supported a *quillay-litre* scrub woodland now support xerophytic scrub (1972, personal communication).

Definite patterns surround the cutting of firewood and manufacture of charcoal. Those activities have resulted not only in patterns on the land that are distinctly Chilean but in quantitative and qualitative vegetation change; e.g., large trees and thickets are usually encountered in ribbons along *quebradas* having permanent water, or occur around springs because firewood is seldom cut within 60 meters of streams or springs. This is a result of the common belief in Chile, already noted in Chapter II, that the cutting of trees around a stream or spring causes the water source to dry up.[6] Another distinctive feature is that trees are usually cut in such a fashion that they will resprout.[7]

In the past the economic activities of many *fundos* in Coquimbo were completely dedicated to the extraction of firewood and the making of charcoal, and surely the barren aspect of the lands surrounding certain *fundos* and *comunidades* today is in large part due to

5. For a description of the different types of wood used for smelting copper and the processes involved, see García Huidobro (n.d., pp. 6-25).

6. This belief is frequently noted in Chilean historical writings and legislation: "Finally, on July 13, 1872, a law was dictated on the cutting of forests that is still in effect. This law prohibits the cutting of trees or bushes in places where springs exist or may appear, affecting those wild trees or bushes located less than 400 meters above (the spring), and less than 200 meters to each side of the springs that originate in irrigated flat lands." Alfonso (1909, p. 12); and Archivo Nacional de Chile, *Archivo Judicial de La Serena,* File 4, Piece 6 (1840).

7. Ancient Spanish regulations concerning the cutting of firewood which have persisted in Chile permit pollarding only.

woodcutting. Traditionally, woodcutters and charcoal burners paid *fundo* owners for rights to cut their wood and/or to make charcoal on their lands. The river valleys and their adjacent interfluves were the first areas to be victimized by the axes of the woodcutters. As those areas were cleared of trees and shrubs, the woodcutters and charcoal burners began to push out of the river valleys onto the dry slopes of the interfluves, and finally into the inner recesses of the cordilleras.

Basically, two kinds of charcoal have been produced in the Province: the hard or heavy charcoals (*carbón de espino* or *carbón de algarrobo*), preferred for heating or cooking; and the light-weight charcoals (*carbón blanco*), made from a variety of light resinous woods. *Carbón blanco* is not fancied for household fuel because it burns too fast. Generally, charcoal made from *espino, algarrobo,* or other hardwoods commands a higher price because of its greater weight and good burning characteristics. The following trees and shrubs are the preferred species for making charcoal in Coquimbo: *espino* (*Acacia caven*), *algarrobo* (*Prosopis chilensis*), *chañar* (*Geoffroea decorticans*), *algarrobilla* (*Balsamocarpon brevifolium*), *carbón* or *carbonillo* (*Cordia decandra*), *peumo* (*Cryptocarya alba*), *litre* (*Lithraea caustica*), *quillay* (*Quillaja saponaria*), *molle* (*Schinus* spp.), *huingan* (*Schinus polygamus*), *crucero* (*Colletia* spp.), *chacai* (*Colletia spinosa*), *talhuén* (*Talguenea quinquenervia*), *boldo* (*Peumus boldus*), *palo blanco* (*Fuchsia* spp.), *barilla* (*Adesmia* spp.), and *Baccharis* spp. Although other species are used for making charcoal, the above are mentioned most consistently in discussions of the trees and shrubs which make good charcoal with *campesinos* (see plate 8). Usually it takes about four kilograms of wood to make one kilogram of charcoal, although the ratio is less with hardwoods.[8] Each sack of charcoal weighs around 50 kilograms. No figures are available on the annual production of charcoal for Coquimbo, nor does it seem likely that such data will ever be collected.

Although nearly every bush or tree is used as firewood, the preferred species include all those used for charcoal, plus the following: *maravilla del campo* or *incienso* (*Flourensia thurifera*), *quebracho* (*Cassia closiana*), *teból* or *tevó* (*Trevoa trinervis*), *culén* (*Psoralea glandulosa*), *paihuén* (*Adesmia arborea*), *colliguay* (*Colliguaja* spp.), *guacho* (*Baccharis concava*), and *Proustia* spp. Certain resinous species such as *Adesmia* spp., *Baccharis* spp., *Flourensia thurifera,* and *Colliguaja* spp. are used in bread ovens because they burn at high temperatures and leave abundant ash. An interesting sidelight is the use of the dried ribs of the *Trichocereus chiloensis* and other types of cereus cacti to make charcoal for gunpowder. Firewood is usually sold by the *carga,* or animal load. A *carga* of firewood for a burro may weigh 120 kilograms or more, while a *carga* of firewood for a mule may weigh nearly 200 kilograms. The usual load for a mule is 80 kilograms per side, or three sacks of charcoal, and the usual load for a burro is 80 or 90 kilograms of dried wood.

The main tools used for cutting firewood are axes, *machetones,* (large chopping-knives) and *barretas.* The *barreta,* which looks like a large pry bar, is used to remove shrubs by the roots, usually killing the plant. Generally, the trunks and roots of a shrub are used for firewood. Firewood is usually cut throughout the year, and plants have less chance of sprouting if they are cut during periods of drought. Although *campesinos* maintain that all of the trees and shrubs can stumpsprout, they note that species vary in tolerance for regrowth. Supposedly, trees are always cut in such a way that they can stumpsprout. However, certain types of domestic livestock eat the young shoots from a sprouting tree or shrub until it dies.

8. Charcoal is made in a number of different types of ovens in the Province. Seeming to dominate, however, are the "hole in the wall" oven, dug into the side of a hill or arroyo near where the wood is being cut, and the "beehive" oven.

The Chilean government has prohibited the cutting of some trees and shrubs in certain seasons (see Appendix B), during which the charcoal burners and woodcutters are supposed to collect only dry wood. The problem with using dry wood for charcoal is that it makes a poor-quality light charcoal, and since charcoal is sold by weight, green wood is cut and the law is violated; besides, there is very little deadwood to collect.

Literature pointing to the degradation of the natural vegetation of Coquimbo through woodcutting and charcoal burning extends back to the colonial period, and ever since the 1540's there have been numerous laws regulating woodcutting; yet those ordinances have been consistently violated.[9] The *campesino,* the traditional offender, as has been pointed out before, is so trapped in the economic marginality of his social and physical environment that he cannot stop cutting wood for fuel. He simply does not have a cheaper, more efficient substitute for firewood. Most *campesinos* are unaware of the laws against woodcutting, and even in areas where the police try to enforce the laws they are still violated. Even where cheap natural gas and gas appliances are available, many *campesinos* prefer to cook with firewood, stating that their beans taste better when cooked over a low wood fire, or that the house smells better with a wood fire.

Although the practice of smelting with wood in Coquimbo ended for the most part in the early 1900's, woodcutting for domestic purposes has increased almost in direct proportion to the increase in population. Over the years, however, the continuous cutting of wood for domestic heating and cooking has probably had a greater effect on the vegetation than the cutting of wood for smelting. It is next to impossible not only to calculate the annual production of firewood and charcoal for Coquimbo but to measure the total impact of woodcutting on the wild vegetation of the Province.

Obviously, the selecting-out of preferred species for firewood and charcoal has reduced or exterminated certain species in various vegetal communities. Many trees have been eradicated by continuous cutting, while others grow back as many-trunked bushes if they come back at all.[10] Sometimes, scavenging for good firewood and charcoal materials goes as far as digging out the roots of shrubs and trees, which has an even more devastating effect on the vegetation. On the whole, it is difficult to evaluate the total effect of woodcutting on the wild vegetation of Coquimbo, especially in conjunction with overgrazing and the widespread clearing for dry farming. Woodcutting in Coquimbo has so damaged and/or impoverished the wild plant cover of most of the Province that regeneration of the wild vegetation seems a remote possibility (see plate 9).

PLANTS GATHERED FOR EXPORT, HOME INDUSTRY, TANNIN, FOOD, AND CONSTRUCTION

A large number of endemic wild plants have been collected for commercial and domestic purposes in Coquimbo. Wild plant products have been gathered historically for export from the following species: *quillay* (*Quillaja saponaria*), *palma chilena* (*Jubaea chilensis*), *algarrobilla* (*Balsamocarpon brevifolium*), *boldo* (*Peumus boldus*), and *pacúl* (*Krameria cistoidea*) (see table 5).

The bark of the *quillay,* which is high in saponin, has been collected for export since the colonial period. The continuous cutting of this tree, for bark and for firewood, decimated it

9. For a review of the state of conservation in Chile, see Cunill (1971b), Elizalde Mac-Clure (1970), and Saelzer (1966).

10. *Quillay* (*Quillaja saponaria*) and *litre* (*Lithraea caustica*) are conspicuous for their habit of growing back as shrubs after repeated cuttings.

throughout its natural range. Before the bark is removed, the *quillay* is usually cut down so it will stumpsprout and not be girdled to death. Once the bark is removed, the wood is used for firewood, to make charcoal, household utensils, stirrups, and ox-yokes. Chilean law specifies that *quillay* trees should be cut down before the bark is removed (see Appendix B, Article 4). This is not always done, however, and the number of *quillay* in Coquimbo is steadily dwindling because of girdling.

Undoubtedly, some of the greatest damage to the *quillay* forests of Coquimbo occurred in the late 1960's when the major *fundos* in the southern part of the Province were

Table 5
Nations Importing *Quillay* Bark and *Boldo* Leaves from Chile in 1967[a]

QUILLAY BARK		
Countries	*Value (dollars)*	*Amount (tons)*
United States	171,651	479.2
Brazil	2,733	5.9
Argentina	1,258	3.8
West Germany	89,107	261.2
Belgium	102	.3
Spain	382	1.0
France	4,779	12.2
England	94,047	279.9
Sweden	525	1.5
Japan	25,829	42.0
Total	390,413	1,087
BOLDO LEAVES		
Canada	699	5.0
United States	1,478	7.1
Mexico	3,867	21.0
Colombia	369	2.0
Ecuador	459	2.1
Brazil	13,415	87.6
Uruguay	746	6.0
Argentina	33,837	204.4
Peru	1,610	7.6
West Germany	7,498	55.9
Belgium	563	4.0
Spain	7,179	45.0
France	27,422	159.8
Italy	17,299	97.4
Holland	365	3.0
Sweden	690	3.0
Israel	151	1.0
Total	117,647	711.9

[a]Source: Chile, Dirección de Estadística y Censos, *Comercio exterior. Año 1967.* Vol. I, *Exportaciones* (Santiago, 1968), pp. 151-153.

expropriated. The *fundo* owners, seeing that they were about to lose their land, allowed bark collectors to remove the bark from the *quillay* on their property without wasting time in cutting the trees down, thus killing the *quillay*. Hacienda Illapel, presently Asentamiento Illapel, is covered with dead and dying *quillay,* especially near Carén, because the trees were girdled to death when the *fundo* was expropriated.

Quillay are confined mostly to the southern half of the Province south of Cuesta el Espino, although they are found along the coast as far north as Tongoy. The *quillay* has a saponin content of 9 to 12 per cent (Muñoz Pizarro, 1973, p. 43; Hill, 1952, p. 209). The bark forms a copious lather in water and is used in washing delicate fabrics and wool. Soapwood, as *quillay* is known in the United States, was utilized during World War II for cleaning lenses and precision instruments. In medicine it is used as an expectorant and emulsifying agent. *Quillay* is a dangerous drug taken orally, however, and its use "to increase the foaming power of beer and other beverages, owing to its ability to dissolve gas, is being discouraged" (Hill, 1952, p. 209). *Quillay* bark has been an important trade export for Chile, and 1,608 tons of bark were exported in 1969.[11] Among the leading buyers of *quillay* bark have been the United States, Great Britain, West Germany, Mexico, Japan, France, and Brazil. According to Ricardo Benzamn and Joaquín Reinecke (1972, personal communication), *quillay* bark is presently selling for $650 to $850 per ton. Very little *quillay* bark, however, is presently being collected in Coquimbo for export. Present regulations prohibit the cutting of *quillay* for bark or firewood except during a short season, and only after government permission has been obtained (see Appendix B). Those regulations are frequently violated, however.

Refined palm syrup (*miel de palma*) and palm nuts (*coquitos*) from the Chilean palm or *palma chilena* (*Jubaea chilensis*) have also been exported from Chile and Coquimbo since the colonial period. Natural palm groves of *Jubaea chilensis* have been recorded from the Río Limarí to the Río Maule, although their distribution in Coquimbo seems to have been rather sparse. The Chilean palm has been eradicated in much of its natural range because of its use in the production of palm syrup (e.g., Darwin [1969, p. 238] speaks of hundreds of thousands of palms in Petorca in 1834, whereas today they are nearly gone). The only region in Coquimbo with large stands of Chilean palms is around Tilama. A few palms are found in the Quebrada las Palmas, south of Mantos de Hornillo, and in a few scattered places in the coast ranges, but they could not amount to more than 20 palms altogether. A toponymic study of the topographic maps of Coquimbo shows a large number of place-names having the word *palmas* in them. In many cases, these place-names do not signify the presence of palms today, but only suggest a high probability of their existence historically. Moreover, many of the existing palms may have been planted for ornamental purposes.

Each palm produces about 10,000 palm nuts, with each *coquito* being a little bigger than a walnut in size. *Coquitos* are much valued as food and have been an important trade item since the colonial period. Trade statistics published in 1898 show that in the previous year Chile exported 220 tons of palm nuts to countries such as Great Britain, France, Peru, Ecuador, Colombia, and Argentina.[12] *Coquitos* are highly valued in Coquimbo, as in the rest of Chile, and can usually be bought from candy vendors in most cities and towns, either plain or candied (*coquitos confitados*). In 1970 only three tons of *coquitos* were shipped to Peru,[13] but most of those were collected from groves at Ocoa and Cocalán, in central Chile.

The factor which has contributed most to the near-extinction of the Chilean palm has been its cutting to make palm syrup. Even today, palm syrup is exported and can be

11. Chile, Banco Central, Circular on exports for 1969 (Santiago, n.d.). (Typewritten.)
12. Chile, *Estadística commercial de la República de Chile, Año de 1897* (Valparaíso, 1898), p. 13.
13. Chile, Banco Central, Circular on exports for 1969 (Santiago, n.d.). (Typewritten.)

purchased in almost any grocery store in Chile. Each palm yields 285 to 380 liters of sap, from which the syrup is made. There were numerous regulations forbidding the cutting of palms to make palm syrup in the colonial period when the government wanted to protect the *coquito* trade with Peru, but until recently these regulations were ineffectual in preventing the near-extinction of the species. Cunill (1971b, pp. 256-259) has reviewed archival materials relating to the cutting of thousands of palms on *estancias* and *haciendas* in central Chile in the eighteenth century. Archival records of the Tilama area, however, have not yielded similar accounts.

The *algarrobilla* (*Balsamocarpon brevifolium*), which is endemic to the area between the Río Copiapó and the Río Elqui, in the provinces of Atacama and Coquimbo (Bowman, 1924, p. 138), is a shrub about six feet high with whiplike branches. It produces seed pods (*tacos*) which are rich in tannin, and a substantial industry based on the collecting, drying, and export of these pods developed in northern Coquimbo and southern Atacama during the late nineteenth century. Small quantities of *algarrobilla* pods were collected for export in the 1830's (Cunill, 1971b, p. 247). The pods were usually harvested at the end of February or the beginning of March (Albert, 1901, p. 275).

In the past the chinchilla population in some areas appears to have been related directly to the number of *algarrobilla* found in an area. Much of the collecting of *algarrobilla* pods was done by chinchilla hunters because the chinchilla stores large quantities of *algarrobilla* pods in its den (Nazarit, 1912). Since those pods, called *algarrobilla de cueva,* had been exposed to the elements for some time, they contained less tannin than freshly collected pods, and therefore brought lower prices on the market.

The *algarrobilla* pods are knocked off the shrubs with small poles and placed in sacks. When a sack is full it contains 55 to 60 kilograms of *algarrobilla* pods (Albert, 1901, p. 275). In 1905 over 4,400 tons of *algarrobilla* pods were shipped from the ports of Coquimbo and Totoralillo (Nazarit, 1912, p. 405). Each *algarrobilla* plant produces 2 to 3 kilograms of pods, and the pods contain 43 to 67 per cent tannin (Muñoz Pizarro, 1973). The *algarrobilla* business was hurt in many years because some collectors would mix *algarrobilla de cueva* and other old pods with the green ones, thereby reducing the overall tannin content of the sack. Competition between gatherers of *algarrobilla* pods and woodcutters, however, led to legislation in 1926 prohibiting the cutting of *algarrobilla,*[14] and seasons were established for collecting the pods. Although the industry still persists, no *tacos* of *algarrobilla* have been shipped from Chile in the last ten years because the total output of pods has been absorbed by national industries (Benzamn and Reinecke, 1972, personal communication).

The leaves of the *boldo* (*Peumus boldus*), a small sclerophyllous evergreen tree, are of minor economic significance but have been collected for export for a century or more in Coquimbo. *Boldo* grows only in the southern and coastal portions of the Province and has been valued traditionally for the medicinal properties of its leaves, which are rich in an alkaloid called boldine (Uphof, 1959, p. 274). In 1966, Valparaíso and San Antonio shipped 758.3 tons of *boldo* leaves to foreign markets, with Argentina, France, Brazil, Italy, and Germany being the largest importers.[15] The *boldo* in Coquimbo has been damaged as much by leaf-cutters as by woodcutters, since the former cut the trees down in order to harvest the leaves.

A number of other wild plant products have been exported from Coquimbo at one time or another, though never in quantities large enough to effect great changes in the plant cover of the Province. As pointed out in an earlier section, some *canelo* bark (*Drimys winteri*),

14. *Publicación extraordinaria 'Atacama'* (Copiapó, 1930?), p. 179.
15. Chile, Dirección de Estadística y Censos, *Comercio exterior, Año 1966* (Santiago, 1967), p. 785.

culén (*Psoralea glandulosa*), and *pacúl* (*Krameria cistoidea*) were exported for medicinal purposes in the past, along with a few other species. *Pacúl* roots were also collected, for dye[16] and tannin (Jiles, 1963, pp. 19-20), and the tar from *brea* (*Tessaria absinthioides*) was supposedly exported from the Copiapó Valley (Cunill, 1971b, p. 245), although apparently not from the valley of Coquimbo, where *brea*, an endemic, grows as a weed. The tar from *brea* was used to calk boats and to paste shoes (Gigoux, 1927, p. 283), and was apparently used as a trade object among the Indians (Cunill, 1971b, p. 245).

Cunill (1971b, pp. 244-245) mentions the export of *sauce* (*Salix chilensis*) from Copiapó in 1699 to Peru for construction wood, and other large trees growing in the riparian forests, further south in Coquimbo, were undoubtedly cut and shipped to Peru for construction materials. An activity of recent years that, according to some botanists, is effecting major changes in the cactus population of some areas has been the collection and export of rare species of cacti to Japan and Europe.

A number of endemic flowering plants have been collected and shipped from Coquimbo for commercial gardening purposes. Species of the following genera have been exported from Coquimbo: *Alstroemeria, Hippeastrum, Leucocoryne, Tropaeolum,* and *Tecophilaea* (Bailey, 1925; Muñoz Pizarro, 1966b). Some *Puya* spp. have been exported to California. One species, *Tecophilaea cyanocroccus,* is nearly extinct from being collected for European markets (Muñoz Pizarro, 1967, p. 80). A number of trees and shrubs which are found in Coquimbo have been sent to Europe and the United States as ornamentals. Common in California are such species as *Quillaja saponaria, Drimys winteri, Jubaea chilensis, Maytenus boaria,* and *Schinus molle* (Metcalf, 1968), although the last was probably introduced from Peru.

Pangue (*Gunnera chilensis*) was once abundant in Coquimbo, as in moist places in much of central Chile, but was nearly wiped out because of its use for tannin. In fact, the only place where a major stand of *pangue* was encountered by the author was near Caleta de Nague, north of Los Vilos, even though *campesinos* told of its growing in various remote areas of the Province. A large tannin industry centered on the collecting of *pangue* in the eighteenth century in Coquimbo, which undoubtedly accounts for the near-extinction of the species in much of the Province. Cunill (1971b, p. 245) quotes an eighteenth-century document in which a grant was given for the harvest of *pangue* in the Valle de Pangue and the *quebradas* of Burleme and Seca near Samo Alto. The eradication of *pangue* apparently correlates with the development of the tallow and hide industry in central Chile during the colonial period (Cunill, 1971b, pp. 252-254). Some attempts were made to cultivate *pangue* for tannin during the colonial period (Cunill, 1971b, p. 253).

The *cardón* (*Puya* spp.) was used historically by the *campesinos* to make a wide variety of fiber products. An attempt was recently made at Los Vilos to develop a fiber industry based on *Puya* fibers. A pilot plant to experiment with methods of extracting the fibers was established just north of Los Vilos in 1964, but no fiber was produced until 1966, when small amounts were decorticated and sent to Los Andes to make floormats, sacks, ropes, and insulation. The plant closed in 1967 because decorticating the fibers from the *Puya* involved undue problems. One problem that was not considered in harvesting the *Puya* was that of mining a nonrenewable resource, since no studies had been completed on *Puya* germination, its tolerances, or its longevity (Kummerow, 1971, personal communication). Attempts are being made to gather such information before *Puya* fiber is collected on a commercial basis again. The yield of *Puya* fiber is increased if the plant is decorticated green, so some sort of

16. For information on the dye plants of Coquimbo, see Ortiz Garmendia (1968), and Jiles (1963, pp. 20-21).

hand-held decorticator must be designed which can be carried into the field. Work is also being carried out by members of the Instituto de Investigaciones de Recursos Naturales to determine the distribution of *Puya* with the aid of near-infrared color photography (Saa, 1971, personal communication).

Local sheep raisers vigorously supported the fiber operation because the *chagual,* as the *Puya* is called in the vicinity of Los Vilos, deprives them of large amounts of wool snagged from sheep by the serrated edges of the plant's leaves. In some areas, the *chaguales* are so dense that sheep cannot penetrate them to graze. The presence of dense *chaguales* in highly degraded areas, however, leads one to conclude that the *chagual* may be a pioneer species.

Archival materials contain hundreds of references on the use in construction during the colonial period of *canelo* (*Drimys winteri*), *espino* (*Acacia caven*), *chañar* (*Geoffroea decorticans*), *algarrobo* (*Prosopis chilensis*), *peumo* (*Cryptocarya alba*), *carbón* (*Cordia decandra*), *litre* (*Lithraea caustica*), *patagua* (*Crinodendron patagua*), *molle* (*Schinus* spp.), and *maitén* (*Maytenus boaria*). Indeed, where large trees of these types are found today, they are still used for construction. Muñoz Pizarro (1973, p. 45) states that *Prosopis* was used even to pave streets during the colonial period in Santiago. Both *olivillo* (*Aextoxicon punctatum*) and *canelo* were cut in the Altos de Talinay for mine timbers and other mining construction purposes at Tamaya, and for houses at Peña Blanca. It is not uncommon to see *coirón* (*Stipa* spp.), *totora* (*Typha angustifolia*), *carrizo* (*Phragmites communis*), *lormata* (the dried ribs of columnar cacti), and the bark of the *maqui* (*Aristotelia chilensis*) used as roofing materials in the Province. Almost any tree that is large enough is used in construction, and light woods such as *arrayán* (*Myrceugenia* spp.), *maqui* (*Aristotelia chilensis*) and *lilén* (*Azara* spp.) are used for building corrals simply because there is not enough hardwood to waste for such construction. Many parts of the north have living fences of cactus which have endured for centuries.

Because of its hardness, *guayacán* (*Porlieria chilensis*) has been used to make spoons, plates, picks, and a variety of other household goods. The making of various types of *guayacán* artifacts is a growing business in Coquimbo. *Guayacán,* a member of the Zygophyllaceae, is an extremely hard wood matched in hardness only by the *Olneya tesota* of the American Southwest.

The *maitén* (*Maytenus boaria*) has a wood that is little esteemed, and only its leaves are valued, being used as livestock fodder during droughts. The soft wood of the *maitén,* however, is sometimes used for making low-quality furniture. In general, the *espino* (*Acacia caven*) is the "all-around tree" of Coquimbo because of its many uses, while the *maitén* is the least-esteemed tree from an economic view. The *campesinos* have a saying that "the *espino* smells so good, and is so useful because the Virgin rested in its shade, while the *maitén* is good for nothing because it shaded the devil."

Some resinous members of the Compositae, such as *Baccharis* spp., *Pleocarphus revolutus,* and *Tessaria absinthioides,* serve as good wattle in wattle and daub structures built in the region. One warehouse constructed in 1750 of *canelo* at Rapel, and wattled with *brea* (*Tessaria absinthioides*) before being plastered with mud, is still standing and quite sound even after scores of earthquakes. Another plant of value in wattle and daub construction is the *Oxalis gigantea* or *churqui.*[17] *Churqui* is resistant to rotting and makes a highly flexible light wall, which is a clear advantage in house construction in such a tectonically active area as Coquimbo. Its use in construction has led to its decimation in much of northern Coquimbo. A work quoted by Bowman (1924, pp. 144-146) shows that houses made out of

17. *Espino* (*Acacia caven*) is sometimes referred to as *churqui.*

cane and *brea* survived the earthquake of December, 1918, in Copiapó with less damage than houses built of adobe and rammed earth. Much of the wood used for construction in Coquimbo, especially for houses of the upper class in La Serena, was imported from southern Chile, Oregon, Washington, and California, and it is not uncommon to see beams of Douglas fir, or even redwood, in some of the old haciendas or townhouses.

A large number of wild plants are consumed by the people of Coquimbo.[18] Table 6 lists a few wild endemics collected by the author that are used as food or to make *chicha,* an alcoholic beverage. Some wild exotics used for food are *Cynara cardunculus* (vegetable), *Foeniculum vulgare* (vegetable), *Nasturtium officinale* (salad green), *Cardamine nasturtioides* (salad green), and *Taraxacum officinale* (salad green). The lists of wild plants used by man for food in this investigation are not comprehensive but show how intimately the *campesinos*' livelihood is tied to the wild vegetation of Coquimbo.

A number of wild plants have religious or superstitious significance; e.g., the *canelo* (*Drimys winteri*) is sacred to the Araucanians; while the *palqui* (*Cestrum parqui*), a plant poisonous to livestock, is tied with yarn in the form of a cross on the front doors of many *campesino* houses, protecting the houses from the evil eye (*mal ojo*).

The following are used for tannin in Coquimbo: pods of the *algarrobilla* (*Balsamocarpon brevifolium*), bark of the *peumo* (*Cryptocarya alba*), roots of the *pacúl* (*Krameria cistoidea*), and pods of the *tara* (*Caesalpinia spinosa*). This last species, a common tree in Peru, Ecuador, Bolivia, and Venezuela, has a fruit which is rich in tannin. It is nearly extinct in Coquimbo, however, and only a few specimens are left in the Ovalle area (Muñoz Pizarro, 1971, personal communication).

Table 6
Edible Wild Plants of Coquimbo

PLANT NAME	USE
Puya spp.	Stalks cooked and eaten
Aristotelia chilensis	Fruits used to make *chicha* and to color wines
Muehlenbeckia hastulata	Fruits used to make juice and *chicha*
Peumus boldus	Fruits eaten
Ephedra andina	Fruits eaten
Jubaea chilensis	*Coquitos* and *miel de palma*
Eulychnia spp.	Fruits eaten
Trichocereus chiloensis	Fruits eaten
Prosopis chilenis	Seeds from pods used to make bread, and an alcoholic beverage
Geoffroea decorticans	Fruits used in an alcoholic beverage and eaten
Krameria cistoidea	Beans ground to make a substitute for coffee
Acacia caven	Beans ground to make a substitute for coffee
Schinus latifolius	Fruits eaten and used to make *chicha*
Carica chilensis	Juice from fruit used to tenderize meat
Mesembryanthemum chilensis	Fruits eaten
Gunnera chilensis	Stalks cooked and eaten
Cordia decandra	Fruits eaten

18. For listings of some comestible wild Chilean plants see: Baeza (1936), Ortiz Garmendia (1969), and Reiche (1901).

The collecting and cutting of wild flowers for domestic use in decoration, or for commercial sale, has probably hurt the natality of some herbaceous species in Coquimbo. Every *campesino* seems to like wild flowers, and it is not uncommon to see a *huaso* (cowboy) with his hat decorated with *arguenita* (*Calceolaria* spp.), or to see table decorations of *Alstroemeria, Leucocoryne,* and *Calandrinia.*

The collecting of wild plants for food, fuel, salable plant products, and construction materials has caused many changes in the structure and composition of the wild vegetation of Coquimbo. Certain species have been completely removed from specific plant communities by over-collecting, and whole vegetation communities have been removed in some cases. Most man-induced changes in specific wild plant communities are next to impossible to measure, however, because of the unknown intensity of particular gathering activities, both individual and collective, over a long period. The collecting of wild plants is merely one more way in which man has altered the wild vegetation of Coquimbo.[19]

LIVESTOCK GRAZING

Since their introduction in the sixteenth century, Old World livestock have played an important role in the evolution of the landscape of Coquimbo. A large export business, mainly to Peru, second only to the export of copper, developed in hides, tallow, and *charqui* in the early seventeenth century. Throughout the colonial period, cattle, sheep, and goats ranged the major valleys and dry interfluves of the Province. During the mining booms of the seventeenth, eighteenth, and nineteenth centuries in the Norte Chico, livestock were important to the miners because they supplied grease, hides, milk, meat, and beasts of burden. Cattle hides were used as containers to carry ore from the mines and as holding sacks in the amalgamation process, while goat hides were used to carry water and wine to the miners. Tallow was used to make candles for mines, and goat and beef *charqui* provided food. Mules and burros moved supplies and ores between the mines and the major settlements in the valleys. Goat hides were also shipped to Peru, the United States, and Europe, to make cordovans during the colonial period.

Traditionally, Coquimbo, with more goats than any other province in Chile, has had more than half of the goat population of the entire country in some years. Coquimbo has also had a relatively high percentage of the mules and burros in the country. In general, goats have predominated on the *comunidades,* poor *fundos,* and small properties in the Province. Cattle and horses are found mainly on the large irrigated *fundos* and *asentamientos,* where good forage is available all year. Coquimbo has very little irrigated pasture, and the bulk of the pasture lands are *praderas de secano,* or unirrigated "natural" pastures. For this and other reasons, few well-bred animals are encountered in the Province, and the majority of these are found on the *fundos.* Since the land reform, however, most of the best stock has been killed. (See table 7 for a breakdown on the numbers of livestock in the Province in 1965.)

About 90 per cent of the Province's goats are *cabras criollas,* small inbred successors of the first goats, introduced by the Spaniards. The few Nubian and Angora goats are confined to a few well-managed *fundos* and *asentamientos,* and to the one state hacienda, or *hacienda estatal* (Tangue), in the Province. The major sheep-ranching areas are along the coast and in the coast ranges as far north as Tongoy. Coquimbo is not good sheep country, however, and

19. The following books were helpful in the preparation of this section: Tadeo de los Reyes (1956), Latcham (1936), Ovalle (1888), Molina (1878), and Goméz de Vidaurre (1889).

Table 7
Livestock Numbers in Coquimbo During the 1964-1965 Agricultural Year[a]

COMUNAS	CATTLE	HORSES	SHEEP	GOATS	MULES	BURROS
La Serena	7,040	1,525	1,720	17,174	217	1,344
La Higuera	35	160	296	8,401	90	1,043
Vicuña	1,678	486	873	8,186	169	428
Paihuano	1,058	683	6,626	9,615	271	944
Coquimbo	5,333	775	2,484	2,383	74	170
Andacollo	232	216	618	9,572	88	599
Ovalle	11,109	2,893	46,577	41,388	937	1,621
Samo Alto	2,283	639	1,181	24,631	397	1,286
Monte Patria	7,414	2,153	17,416	47,751	1,074	1,652
Punitaqui	7,479	2,241	11,701	34,311	634	1,831
Combarbalá	2,435	1,638	8,468	56,156	1,266	2,817
Illapel	12,608	2,440	18,221	12,563	366	800
Salamanca	17,439	4,821	10,446	24,787	387	1,510
Los Vilos	6,926	2,774	45,769	16,035	440	441
Mincha	3,306	3,350	34,501	28,192	1,023	2,445
Total	86,375	26,794	206,897	341,145	7,433	18,931

[a]After Chile, Dirección de Estadística y Censos, *IV censo nacional agropecuario. Año agrícola 1964-1965, Vol. V, Coquimbo* (Santiago, 1968).
The *comunas* are on map 1.

the northernmost operations are marginal at best. The dominant breeds of sheep in the Province are Hampshire Down, Suffolk Down, and the ubiquitous Australian Merino. Some other breeds of sheep are also raised, though only in small numbers.

A long history of overgrazing, trampling, and the spreading of seeds via hair and manure of livestock has modified the wild vegetation of Coquimbo, especially in conjunction with woodcutting and clearing for dry farming. The history of grazing by livestock, as pictured for the Norte Chico by Gastó and Contreras (1970, p. 91), seems accurate:

> The changes observed in the species utilized by livestock have been parallel to the regression of the vegetation. In the beginning the principal components of the herbaceous community were high grasses or bushes of high forage value that could be utilized by cattle and sheep. The overuse of the rangelands signified the reduction of the population density of these species, so as to transfer the range into a degraded state. The goats then began to be important. The goats increased because in most cases they are the animals that can best utilize degraded rangelands. The stocking rate, however, was so much greater than the carrying capacity of the rangelands that the goats continued the deterioration of the ecosystem until the range arrived at the point where the vegetation cover was insufficient to protect the soils from the dangers of erosion. It is in this stage that we find many of the semiarid to arid rangelands of the Norte Chico.

This is a realistic picture of the history of grazing in the Province of Coquimbo, but one must not infer that all rangelands in the Province once had a higher carrying capacity for cattle than they have today. The desert scrub communities of the Province have always been marginally productive for cattle. Historically, cattle grazed and browsed in the valleys, whereas the goats and sheep were confined to the dry interfluves and coastal terraces and plains.

Since colonial times, the survival of livestock during summer droughts has depended on transhumance in much of Coquimbo. Transhumance involves the moving of livestock from the coastal lowlands, interior valleys, and dry interfluves of the Province to summer pastures or *veranadas* in the Cordillera de los Andes.[20] The patterns of transhumance are similar in Coquimbo to those in other semiarid mediterranean climates in the world.

Ephemerals, most of them introduced or naturalized, make up the bulk of the forage plants in the degraded pastures, where most of the endemic perennial grasses and shrubs have been eliminated. In the spring, these ephemerals die off and the livestock, unable to survive on the overstocked ranges, are taken to summer pastures in the high cordilleras. Except where irrigated pastures are available for use in the valleys, the animals are kept in lowland ranges for as little as six months before being moved to pastures in the Andes. Transhumance may not have been a necessity in the past when the ranges were not yet decimated by overstocking and uncontrolled grazing. The majority of the animals moved in transhumance are goats and sheep, although mixed herds of livestock are frequently encountered. The majority of sheep are the property of the large *fundos* and *asentamientos.* Most of the sheep, however, are kept in the more humid meadows on the Argentine side of the Andes during the period of transhumance. Although a few cows, horses, burros, and mules are taken to the cordilleras in the summer, the majority are kept in lowland pastures.

The movement of animals in transhumance takes place along the major transverse valleys and their tributaries in the Province. The animals are either herded or transported by trucks to the Andes. The livestock drive to the summer pastures usually begins in November, but if the winter has been particularly harsh it is postponed until December. The animals

20. For additional information on transhumance in the Province of Coquimbo, see Aranda (1971a and b).

spend five months in the summer pastures, usually beginning their descent in April. In some cases, however, they may not be brought down until June or July, although the chance is great of losing them to a sudden winter storm at such late dates. The time spent in the *veranadas* by the animals is shorter in the south than in the north. Frequently, the herders go to the cordilleras in early spring, before the arrival of their herds, in order to spread the waters flowing into the meadows, thus increasing forage areas.

According to Aranda (1971a, p. 150), the average annual number of livestock moved through customs from 1959 to 1969 was: 14,243 (the Elqui and its tributaries), 146,292 (the Limarí and its tributaries), and 24,022 (the Choapa and its tributaries). Those figures do not include livestock moved to the cordillera through other river valleys in the Province and their tributaries. The trip, if the animals are driven on foot, usually takes fifteen to twenty days each way. Sometimes large numbers of animals are lost in the move, especially if they are in a weakened condition when they start the trip. Frequently the herders start for the cordillera too early and their animals are killed by an unexpected storm (Delley, 1961). At present, the majority of the animals from the coast are trucked to the cordillera, but because the meadows are so badly degraded many animals are taken south to Aconcagua Province or to the Quilimarí area for summer grazing. Nearly 30 per cent of the livestock in the Province are moved to the Andes in the summer. Two out of every three animals, however, are taken to summer pastures on the Argentine side of the cordillera (Aranda, 1971b, p. 54).

Goat cheese is made during the summer stay in the mountains and is brought down periodically to be sold in local market centers along with firewood and charcoal. Pigs are sometimes taken to the cordillera to be fattened on the whey left from cheesemaking. Almost all of the *vegas* in the Andes belong to *fundos* or *asentamientos* and are used by the owners or rented to small holders, goat herders, or *comuneros*. On the way to the cordilleras the animal drivers usually rent pasturage from *fundos* or from friends along the route, who expect them since they make the trip every year.

Goat cheese is simple to make in the field but is usually made under unsanitary conditions. About four liters of goat's milk are required to make one kilogram of cheese. Since a native goat gives only one-quarter to three-quarters of a liter a day, many goats are required to make cheese in salable quantities. A herd of 500 goats can produce around fifty kilograms of cheese a day. The goats supply the *campesino* with a substantial income as well as a substantial supply of nutrients. With goat cheese selling at the equivalent of $1.35 a kilogram in 1971, it is small wonder that most *campesinos* prefer goat raising to farming. Most of the goat herders do not get the full price for their cheese, however, having to barter it through intermediaries in exchange for foodstuffs and manufactured wares. Goats make up the majority of the livestock involved in transhumance in the drier valleys of the north, with sheep and cattle increasing proportionately as one moves south (Aranda, 1971b, p. 56). This distribution is an obvious result of more rainfall and better livestock conditions in the southern portions of the Province.

Except on a few of the fenced *fundos* and *asentamientos*, grazing in the Province is uncontrolled. There are few fences, and goats and sheep browse and graze where they wish, with usually only a small child accompanying them to keep them out of cultivated areas. Goats eat the starch supplies and sprouts of the slow-growing desert shrubs until the bushes die. Sheep, with their bifid lips, eat perennial grasses until the grasses are so weakened that after a short drought they too die. Programs for reseeding spent pastures or for other types of range management have been carried out in the Cajón de Maipo by the Universidad de Chile, and at Corral de Julio in Coquimbo by the Corporación de Fomento de la Producción, but these programs have largely failed to diffuse information to the *campesinos*. Scientists

are attempting to apply twentieth-century range management to a sixteenth-century system, and on only a few well-managed *fundos* have improved range-management programs been successful.

To scientists interested in livestock production in Coquimbo, the problem lies in channeling the energy of the *matorral* and desert scrub to the people. No governmental agency has yet been able to change the people's attitudes toward goat herding. This is largely the result of the inertia in the *campesino*'s system of living on the land, and of the inability of the people who are pushing for change to understand the *campesino*'s culture or his system of land tenure; e.g., government programs on improved goat-breeding, range management, and more sanitary cheese production at Punitaqui were rejected by the *campesinos* as impractical.[21]

The *campesino* does not think of grazing in terms of sustained yields. He counts on the winter rains and the rapid growth of highly palatable ephemerals to feed his livestock. He allows his goats to increase in number until they starve to death and/or the next drought kills them. The goats usually eat the annuals before they have had a chance to go to seed, so that, year after year, the range continues to degrade and its carrying capacity decreases. When a drought destroys a *campesino*'s herd in Coquimbo, he takes a job in the mines in the north or goes to the coastal cities, waiting for news that the rains have returned so he can go home and start raising goats again and repeat the same grazing cycle. After one or two years of abundant winter rainfall the goat population explodes, only to be killed off when the next drought occurs. This is the way that goats have always been raised in Coquimbo. The *campesino,* however, recognizes the rangelands as degraded only in the most obvious circumstances, and he has no concept of range management, in the "western" sense at least. The *campesino* blames the bad years strictly on the lack of rainfall, and when it rains he is back in business again.

The goat is widely distributed in Coquimbo because of its unquestioned ability to survive, even to thrive, on the sparse plant cover that has historically been a part of the vegetation landscape of the Province. Goats tolerate well the low palatability of *matorral* and desert scrub. When feed is scarce, and of low nutritional value, larger animals have the disadvantage of requiring more for maintenance, whereas the smaller goat can cover sufficient ground to meet his daily nutritional needs. The *cabra criolla* of Coquimbo is a genotype which is well bred for the Province, and its durability should be taken into consideration before attempts are made to introduce new breeds. Droughts take an unbelievably high toll of the goats in the Province (e.g., over 351,000 goats were lost during the 1960-61 drought, and nearly 275,000 in the 1967-69 drought) (Aranda, 1971b, p. 13). The goats are quite resilient, however, and increase at tremendous rates after a few wet years. One might say that the ranges are so degraded that animal tenure depends solely on the infrequent winter rains. Soon, however, even the rains will not be enough to carry the numbers of goats which Coquimbo has had in the past.

For many years certain individuals in Chile have advocated abolition of the goat in Coquimbo because of the great damage it has done to the wild landscape. As stated earlier, it is not the animal but man's mismanagement of the goat that is at fault. The goat is only a tool in the hands of man, and until the system of grazing and browsing changes in the Province, the wholesale destruction of the environment will continue. So many attempts

21. Occasionally a government-sponsored program fails—which only strengthens the *campesinos*' resistance to change (e.g., *El Mercurio,* November 17, 1971, "Insólito caso de vacuna mortal en Illapel," describes the death of fifty cows during a government immunization program).

have been made to abolish the goat that *campesinos* are quite defensive when discussing their animals, and few are willing to admit that their goats are capable of destroying vegetation. The milk goat, or *cabra criolla*, is a particular problem, however, because it has to return home to be milked every night. Hence, all the vegetation for a kilometer or two around the *campesino*'s house is liquidated by the daily comings and goings of the goats, and also by young goats that remain around the house for months, eating everything in sight. In Coquimbo the places where goats are milked have to be changed every year to avoid these deserts around *campesinos*' houses. Yet the introduction of meat goats, which do not have to be milked, would create a whole complex of new problems.

Although *campesinos* stated that they were able to evaluate range conditions, upon further questioning they could not characterize a good or bad range in terms of plant cover or composition. Virtually every plant in Coquimbo is palatable for browsing or grazing, even the species which are poisonous to livestock; but those *campesinos* interviewed were unable to list a hierarchy of palatable plants for livestock in their local area.[22] Establishing a hierarchy of the palatable plants for the Province as a whole would be difficult, however, because of the tremendous ecological variability and intensity of human disturbance encountered there. The *campesino* makes scant attempts to appraise range conditions, depending instead on transhumance and the growth of winter annuals to support his animals.

A large number of plants are noted by *campesinos* to be poisonous to livestock. Livestock poisoning, however, may occur in many ways. Not only can poisoning occur from commonly toxic plants, but under certain conditions from normally valuable grazing species which may become toxic by accumulating excessive quantities of nitrate, hydrocyanic acid, selenium, or other substances (Schmutz *et al.*, 1968, p. 7). The most frequent condition resulting in the poisoning of livestock in Coquimbo is the shortage of desirable forage on the range, since most poisonous plants are invaders in deteriorated ranges. Because poisonous plants are usually relatively low in palatability, the animals graze or browse them in significant amounts only when forced by hunger or mineral deficiencies. When forage is adequate, animals seldom consume enough of any one species for poisoning to result. Although a large number of plants in Coquimbo are poisonous to livestock, the most common are *Astragalus* spp., *Datura stramonium, Euphorbia peplus, Xanthium spinosum, Brassica* spp., *Nicotiana glauca, Triglochin maritimum,* and *Cestrum parqui.*[23] *Guayacán* (*Porlieria chilensis*) is frequently noted by the *campesinos* to be poisonous to animals, but it is grazed by goats and apparently makes them sick only when grazed in large quantities.

Undoubtedly, the abundance of certain semi- or altogether non-poisonous species of *Pleocarphus, Baccharis, Haplopappus, Flourensia,* and *Bahia* in degraded pastures is due to their low palatability to livestock. Fires are seldom used in range management in the Province, and since there is so little ground cover, any fires that occur are quite limited in extent. At the same time, one frequently observes *campesinos* setting fire to cacti in order to remove the thorns so their goats will have subsistence in the general absence of palatable vegetation during periods of extreme drought, but such fires are of little consequence.[24]

The literature is extensive on experimental introduction of exotic forage plants to Coquimbo, but few have developed into range-management programs in the Province. The

22. For lists of some wild forage plants in Coquimbo, see: Muñoz Pizarro (1955), Jiles (1963, pp. 24-26), and Pisano Valdés (1966b).

23. For information on poisonous plants in the Province see: Muñoz Pizarro (1955, pp. 32-34), Ortiz Garmendia (1966), and Fuentes (1922).

24. The *palo gordo* (*Carica chilensis*) is almost extinct in Coquimbo because it is often uprooted and smashed as fodder for livestock during droughts.

plants which scientists are experimenting with are mainly weeds which were introduced centuries ago, or endemic plants that have been wiped out by overgrazing.

Much of the grazing damage observable on the ranges of Coquimbo is frequently blamed on goats but was originally caused by mixed herds of livestock. Because the goat can persist on a range of lower productive levels than can cattle and sheep, however, the latter two have long since disappeared from the degraded range. The causes of range deterioration in Coquimbo are quite diverse, and measures to counter and correct the deterioration must also be diverse. No wholesale introduction of remedial measures evolved in different cultural systems and different physical ecological circumstances can be expected to arrest existing deteriorative trends in Coquimbo. Merely to blame the goat for what has happened, or to advocate its elimination without adequate study of all the cultural and economic factors involved in goat grazing will not solve the problems facing the *campesino* or correct deteriorating range conditions in the Province.

The goat is an efficient means of maximizing the benefit of phytomass having low palatability to other animals, and, in combination with other livestock, of establishing efficient grazing practices. Goats have been used for years in Coquimbo by the better managed haciendas in a system of dual grazing with sheep to maintain maximum range production (Morgan, n.d.). Since sheep are better grazers than browsers, the ranges which sheep have grazed heavily become brush-covered. The shrubs shade out grasses and snag valuable wool. For many years, *fundo* owners have sent men out to clear the brush by hand and/or burn it where possible; they have found now that they obtain greater productivity from the range by allowing goats to eat the shrubs back, and then grazing the sheep. This method of dual grazing not only keeps the brush back but allows the grasses to recover.

Dual grazing and rotational grazing are only two ways in which the productivity of the wild vegetation of the pastures of the dry interfluves might be increased in terms of livestock use. Some sheep owners believe that it is impossible to maintain pure grasslands in the Province for sheep because in dry years the only grasses or annuals that reach seed are those which grow in the shade of bushes. At any rate, under existing systems of livestock tenure in Coquimbo, many perennial shrubs and grasses are being killed off. Seed production and the regeneration of annuals and grasses are retarded, and the plants that survive are lower in nutritional value. Domestic livestock not only kill plants by trampling but also spread some plants and aid their germination. Some species indigenous to Coquimbo, such as *Atriplex coquimbensis, Atriplex repanda,* and *Baccharis racemosa,* have been nearly eliminated by overgrazing.[25]

Contrary to what one might suspect, the *campesinos* do not slaughter their goats during the frequent droughts, and they do not eat the sick and dying goats. Predators take a heavy toll of young sheep and goats, accounting for upward of 10 per cent of total animal losses in any given year. The main predators are foxes, vultures, condors, wild dogs, mountain lions, and wildcats. A number of diseases affect goats in Coquimbo. Hoof and mouth disease (*aftosa*) runs rampant in some years. In general, disease accounts for few losses and is a poor third place, after starvation and predation, as a killer of livestock.

Grazing and browsing can have severe effects on plant communities since each range species in a community differs in germination, sprouting, flowering time, growth rhythm, and palatability. Grazing and browsing also lead to the withdrawal of minerals from the soil, the selective destruction of highly palatable species, the physical destruction of top soil (soil

25. For a list of the species that are being studied for reseeding and introduction in Coquimbo, see Gastó and Contreras (1970, p. 94).

creep and trampling), the invasion of weeds and plants that are generally more xerophytic, and microclimatic change. In most pastured areas in Coquimbo, plant communities tend to regenerate themselves with plants having lower water requirements; and, in general, according to *campesinos,* the rangeland ecosystems of the Province are more arid today than in the past.

There is virtually no system of range management in Coquimbo, nor is there any concept of stocking numbers or of range carrying capacity. For the most part, livestock management, if one can use the term, has changed little in Coquimbo since the Spaniards introduced Old World livestock, in the sixteenth century. The effects of rampant overgrazing can be seen throughout coastal Coquimbo and on the slopes of the interfluves that separate the major river valleys, where large areas are completely denuded of vegetation and are badly eroded. Even though grazing in Coquimbo may change the character of the vegetation without reducing ground cover enough to cause erosion, the heavily grazed plant communities become more weedy, thorny, xerophytic, and less productive to livestock.

In general, the more arid the plant community being grazed, the more important it is to regulate stocking rates so as to protect the micro-environment. This may mean maintaining a plant community near its ecological climax, however, which will usually require a low level of range utilization (Moore and Biddiscombe, 1964, p. 228). It appears that range managers in Coquimbo will have to concentrate on maintaining an environment suitable for the germination of seeds and the protection of young seedlings; they will also have to plan on avoiding heavy grazing after the rains so that the seeds of desirable species can mature. These objectives might be achieved by deferred grazing, or by setting aside part of the grazing area during droughts. Before any of this can take place, however, the ranges will have to be fenced off and the government will have to seize large segments of the land to control grazing. Because none of these solutions seems feasible, however, Coquimbo's range problem must be solved mainly through changing the attitudes of the *campesino.*

The rangelands are degenerating, and year after year they support fewer livestock. The *campesino* is not in ecological equilibrium with the land as some believe; in fact, the land is becoming less productive and supporting fewer people. No range-management or conservation programs are being implemented in Coquimbo at present. The government is too bound up in the "battle for production" to recognize the rape of the land which is occurring in Coquimbo and the rest of Chile, or the probable ecological consequences for future generations of *chilenos.* Man's mismanagement of livestock has heavily depreciated the wild vegetational resources of Coquimbo, and the prospect seems remote that the wild plant communities can regenerate themselves in the Province's rangelands in the foreseeable future without major changes in present land-use patterns.

DRY FARMING

Wild vegetation in the coastal and interior portions of Coquimbo south of the Río Elqui has suffered massive destruction from a system of shifting cultivation on dry lands, called *lluvias, siembras de rulo,* or *cultivos de secano,* in which the main crops are wheat, barley, cumin, peas, lentils, and garbanzos.[26] In fact, from aerial photographs it appears that 30 per cent or more of the coastal terraces and seaward-facing slopes of the coast ranges have been cleared at one time or another for dry farming. Farming by *lluvias* on an annual basis

26. Shifting cultivation in the Valle de Putaendo is sometimes referred to as *curbén* (Baraona, 1972, personal communication).

extends farthest north in the Province along the coast, almost to Guanaqueros, because of the moderating effects of the daily fog or *camanchaca,* while the Río Hurtado is the northern limit for this activity in the interior. Dry farming has always been a marginal activity and is profitable only after heavy winter rains. It is a form of shifting cultivation because, once the fields are cleared, they are farmed for only three or four years before being abandoned; then new areas or once-abandoned fields are cleared and used again. No soil conservation is practiced in this system, and the abandoned fields, usually left to goats and sheep, soon become gullied and eroded, exhibiting the worst man-caused erosion in the Province.

Because the majority of the *lluvias* are on shaded slopes, facing the advancing fogs, they are more susceptible to erosion than if they were on flat land; furthermore, most of the level land and moderately sloped land in the Province is irrigated. There is no contour plowing, rotational cropping, or fertilizing of the lands used for *lluvias.* An area is simply cleared, plowed, seeded; and, once it loses productivity, abandoned. Some abandoned *lluvias* are so depleted of soil nutrients and water that they are almost completely devoid of vegetal cover, lacking even the ephemerals that sprout abundantly elsewhere after the winter rains. In some fields only an occasional *Cassia* sp. or a *Flourensia thurifera* has survived because the roots of these plants were not completely removed during the original clearing operations.

One of the most degraded areas in Coquimbo, because of farming by *lluvias,* is found around Peña Blanca in a rough rectangle that stretches from Salala, on the Río Limarí, south to Bahía Teniente, east of Punitaqui, north of Ovalle, and west again to Salala. Another area equally degraded by *lluvias* stretches in a wide band from north of Canela Baja south to the Río Choapa around Mincha and Tunga.

Yields from *lluvias* are so meager that the *campesinos* barely break even in most years. Dry farming depends almost exclusively on winter rain, and fertilizers rarely pay for themselves in increased yields; in some cases not even the lower-yielding drought-resistant wheat varieties are profitable. No other human activity has caused more damage to the wild vegetation and soils of Coquimbo with fewer economic benefits to the people than dry farming, and it should be banned in the more arid parts of the Province. It is an economic activity which is carried out against the greatest of environmental resistances in Coquimbo.

According to informants, the productivity of the *lluvias* decreases with each cultivation cycle, and an average yield of wheat is only 18 sacks (each sack weighs one *quintal,* or about 70 kilograms) for each sack sown, or 10 bushels per acre. The *lluvias* are usually planted after the first winter rains (in June, July, or August) and harvested in November or December. Even in rainy years, however, the grain crops may be lost to diseases or insects.

Much of the luxuriant vegetation once found on the peaks of the coast ranges was destroyed because those areas were cleared for *lluvias.* One can observe the effects of such clearing on the seaward-facing peaks of Talinay and Fray Jorge. As pointed out earlier in this section, Peña Blanca is an extreme example of the degradation caused by dry farming in the Province, for every piece of ground in that area has been cleared at one time or another for dry farming (see plate 10). Only sparse shrubby vegetation can be found in the ravines or around rocky outcrops, and most of this has been cut for firewood or browsed by goats; even the cacti have been used for fuel or in house construction.

Some perennial shrubs that are pioneers in abandoned *lluvias,* partially surviving because of their relatively low palatability to livestock, are *Gutierrezia paniculata, Haplopappus foliosus, Bahia ambrosioides, Proustia pungens, Flourensia thurifera, Pleocarphus revolutus, Tessaria absinthioides, Moscharia pinnatifida, Senecio* spp., *Ophryosporus triangularis, Baccharis* spp., and *Brassica* spp. In many cases a single shrubby species dominates and clearly

delimits an old abandoned field. Indiscriminate clearing for dry farming, in conjunction with continuous woodcutting and uncontrolled grazing, has played havoc on the unprotected slopes of the dry interfluves of the Province, and has taken much land out of production. Further, in the majority of the *lluvias*, especially those on *comunidades*, the land is not given a change to recover after the fields are abandoned; instead, the vegetation remains in a state of disclimax because goats and sheep are allowed to graze the abandoned fields.

FIRE

No long-term fire records exist for the Province of Coquimbo, and testimony on the fire history of the Province depends on eyewitness accounts. According to *campesinos*, however, there have been few if any large fires or *incendios* in the Province other than in the southernmost coastal and interior portions. Except on rare occasions, fire is never used to clear land for *lluvias* or as a means to improve grazing. The wild vegetal cover of the Province has become so degraded during the last century and a half that it has little ability to carry fire. Fires probably played an important role in modifying the landscape in pre-Conquest times, especially in the riparian areas where fires may have been used for forest clearing or hunting, though there are no historical data to support this. In fact, from available historical and archaeological data, it is doubtful that the Indians used fire deliberately for hunting or to clear land; only one account has been encountered that mentions aboriginal use of fire for land clearing, and that is an instance of the burning of field stubble.[27] Large fires undoubtedly occurred in the chaparral of southern Coquimbo but are rare today. Lightning-caused fires are unknown in the Province.

Most of the endemic vegetation has the ability to sprout, at least after a low-intensity fire, but no fire-climax plant communities have been identified in the Province. The *espinal* of Coquimbo is definitely not fire climax or related to fires in any way. Because of overgrazing there are seldom enough dry grasses or other herbs left to carry a fire, especially during summer drought, when fires are most frequent, and the *Acacia caven* and other woody shrubs and trees are usually too far apart to spread a fire. Man-induced fires, at least during the last two centuries, have had little effect on the wild vegetational landscape of Coquimbo and appear to be among the least important of the human activities that have led to changes in the structure and composition of the vegetal cover of the Province.

INTRODUCED OR NATURALIZED PLANTS

As pointed out in Chapter II, introduced or naturalized herbs have a numerical ascendancy over native herbs in most of Coquimbo; few of these exotic species are considered weeds in Chile, because even common garden weeds have some type of use. The term "weed" is rather anomalous, because a plant considered a weed would have no use by most definitions. For simplicity's sake, however, and in order to point out the ability of man to spread plants that are neither crop plants nor ornamentals,[28] the term "weed" is used here to simplify the discussion of introduced plants. According to the *campesinos*, there are

27. "When it [maize] sprouts they protect it, so the birds do not eat it, and once it is well above the ground with two of three leaves, the fields and herbage are dry and there is a lot of it and it is very high [sic]. They set fire to it until it is ash and even though bad [sic] more is produced from the leaves of maize" (Bibar, 1966, p. 41).

28. Some crop and ornamental plants have escaped from cultivation, however, and have taken on the characteristics of weeds.

few weeds in the *campo* or wild landscape. Plants which a *campesino* involved in farming considers weeds might not be considered such by a *campesino* who raises goats. Appendix A lists a few of the introduced or naturalized plants which grow in disturbed areas as weeds or escapees. The list also includes some Chilean endemics which grow as weeds in other mediterranean parts of the world.[29]

Most of the introduced or naturalized plants, aside from crop plants and ornamentals, are native to the Mediterranean region, but there are some also from Asia, Africa, and Australia, and a number of species that have been introduced from California. Endemics that grow as weeds are numerous in Coquimbo, but except for four or five species that have been introduced from Chile into other areas, they are difficult to define because most endemics have some kind of use. Only a few species with a propensity for growing as pioneers are mentioned here as weeds.

The exotic or weedy composition of any given area is determined not only by various physical phenomena but by the kind and intensity of human disturbance. In other words, the composition of weedy species differs in an abandoned *lluvia* from that in heavily cut or grazed areas. Many common weeds, however, have escaped from agricultural areas and become a part of the wild vegetation by displacing native plants. Many of the introduced or naturalized herbs have become valuable forage plants in Coquimbo and make up the bulk of the winter annuals on which the livestock depend for the bulk of their sustenance.

Many of the weeds found in California have undoubtedly come from the Mediterranean world via Chile, and large numbers of weeds that are abundant in Chile were probably introduced to California during the Gold Rush, when Chile was a leading exporter of wheat to California. Also, plants such as the California poppy (*Eschscholzia californica*) found their way to Chile via the numerous United States ships which once plied the Chilean coast. An interesting analysis of adobe brick in California, if extended to Coquimbo, would shed some light on the periods when certain weeds were introduced into the Province. Hendry (1931) established three periods for weed introductions into California by identifying selected weedy species from adobe bricks: the Pre-Conquest Period (to 1769), *Rumex crispus, Erodium cicutarium,* and *Sonchus asper;*[30] the Mission Period (1769-1824), *Poa annua, Chenopodium album, Chenopodium murale,* and *Amaranthus retroflexus;* and the Post-Mission Period (post 1824), *Lolium temulentum, Brassica campestris, Brassica arvensis,* and *Cirsium lanceolatum.*

Introduced and naturalized herbs arrived in Chile in a wide variety of ways. Many weeds were introduced as forage plants, while others came in the ballast of ships, in the hair of livestock, in packing materials, in grain shipments, or with seeds. A wide variety of crop plants, as well as ornamentals, have been intentionally introduced into Coquimbo, and some have escaped from cultivation. Most trees in the major river valleys of the Province are exotic. According to Gay (1865, II, p. 154), the *alamo* or Lombardy Poplar (*Populus nigra italica*) was introduced into Chile around 1810. *Eucalyptus* spp., *Pinus radiata,* and some kinds of willows (*Salix* spp.) are also conspicuous exotics in the river valleys. The blackberry (*Rubus* spp.), introduced by European immigrants many years ago, grows as a weed throughout central and southern Chile (Santa Cruz, 1935, p. 12).

29. Some indigenous plants in Coquimbo which have been carried to California as weeds are: *Cuscuta racemosa, Gnaphalium chilense, Eleocharis pachycarpa, Madia sativa, Mesembryanthemum chilensis, Sanicula crassicaulis,* and *Sanicula graveolens* (Munz, 1959).

30. Frenkel (1970, pp. 40-42) does not think Hendry was justified in claiming that these three species were present in California prior to Spanish settlement in 1769 because of their disturbed habitat requirement.

Some endemics appear to have been spread because of man. *Calandrinia* seems to be spreading in Coquimbo, as is *Tessaria absinthioides;* the latter is found near water throughout the Province and at elevations approaching the upper limits of vegetation. The *Loasa tricolor* is a noxious weed which is taking over fields not only around Ovalle but also in other areas. Thickets of this weed are almost impossible to penetrate when the *Loasa* is green, and the weed leaves a rash on the human skin much like that left by stinging nettle (*Urtica* spp.). *Loasa tricolor* is eaten by livestock when it dries out in the summer, however. *Oxalis peraltae* gives many abandoned *lluvias* around Ovalle an almost solid red color in the spring. The *Acacia caven* is becoming a weed in some overgrazed areas, although large *Acacia caven* are much desired for firewood and charcoal. Ice plant (*Mesembryanthemum crystallinum*) is spreading throughout the northern coastal portions of the Province from Lagunillas to Choros Bajos, although it, too, is eaten by goats when it dries out in the summer.

As stated in an earlier section of this chapter, most of the endemic perennial grasses of Coquimbo have been killed by overgrazing, and the pastures of Coquimbo have been taken over by such exotics as *Hordeum* spp., *Avena* spp., *Erodium* spp., *Briza minor, Bromus mollis,* and *Trifolium* spp. Continuing experiments with exotic forage plants will undoubtedly lead to the introduction of other herbs and shrubs.

SOIL EROSION

The horrendous soil erosion of much of the Province occurred in the last century or two. Man's mismanagement of the soil and vegetal resources of the Province, however, has been contributing to this event ever since the first Spanish *entradas.* Only the semiarid climate and the nature of the dominant winter frontal precipitation keeps the erosion from being worse than it is. The widespread destruction of the plant cover and the trampling of the soil by livestock have limited the ability of the soil to hold water, causing uncontrolled runoff and consequent gullying and flooding. Since the interfluves are of marginal use for crops, the farmers are not greatly concerned with erosion. Even so, in certain areas the damage to the watershed is reflected in increased runoff, microclimatic change, and the loss of potential irrigation water.

The effects of erosion and sedimentation on the vegetation of Coquimbo are little understood, and it is questionable whether the topsoil in some areas is being removed as rapidly as some suppose. In abandoned *lluvias,* however, large amounts of soil have been lost to erosion, and the loss of topsoil, combined with the loss of soil minerals and soil water due to removal of the vegetal cover and soil trampling by livestock, has rendered vast areas of Coquimbo virtually useless for agriculture. Once the soil is lost it cannot be restored, and even under the most favorable conditions it takes centuries, if not millennia, to build a single inch of topsoil (Bennett, 1955, p. 14). Granted that the soils of the interfluves in Coquimbo are marginal to begin with, "proper management" could make both the soils and the wild vegetation more productive than they are at present and therefore more beneficial to the people.

Because of the steepness of the slopes on which the vast majority of the *lluvias* are planted, erosion can be great during an occasional deluge. In most cases, these steep slopes should never have been used for crops, even with suitable soil-conservation practices, and should have been used only for controlled grazing. Thousands of acres of productive and/or potentially productive lands have undoubtedly been lost or had their productivity decreased by man's mismanagement. Soon there will be no new areas to clear for *lluvias,* and abandoned lands will either have to be reclaimed or dry farming given up completely.

Solutions to the problems of erosion are simple in the technical sense at least, and only the conservatism of the *campesino* stands in the way of change. The majority of the *campesinos* have no concept of erosion, and those who do are unable to do anything about soil losses on their lands because they lack the knowledge, capital, and, in most cases, the desire to change their present agricultural practices.

DESTRUCTION OF THE NATIVE FAUNA

No studies have dealt with the ecological interrelations between man and wild animals in the Province of Coquimbo. The two large herbivores which inhabited the Province in historic times, the *huemul* (*Hippocamelus bisulcus*) and the guanaco (*Lama guanicoe*), were nearly extinct by the time of the first Spanish *entradas.* Now the *huemul* is extinct in both Coquimbo and the rest of northern and central Chile, and the guanaco is found only in the high Andes except for a few animals in the coastal ranges east of Choros Bajos. Several small vertebrates appear to be faced with extinction in the Province because they have been over hunted and/or their habitat has been destroyed. Two small mammals which have suffered greatly because of man are the chinchilla (*Chinchilla chinchilla*) and the *vizcacha* (*Lagidium viscacia*), both nearly exterminated by hunting, the former for fur and the latter as food.

Coquimbo is a faunal desert, at least to the layman; even the early Spanish chronicler Mariño de Lovera (1865, p. 52) mentions the paucity of wild animals in northern Chile. One can travel many days in the Province without seeing any large animals or rodents. Only birds and insects seem conspicuous. The fresh-water fauna were wiped out years ago, and only a few native fish and freshwater shrimp, or *camarones del río,* are notable.

The fox (*Dusicyon* spp.) and members of the cat family seem to fare well around man, preying on livestock. Skins from mountain lions (*Felis concolor*) are seen occasionally in the small mountain villages, and lion hunts are held periodically. The condor (*Vultur gryphus*) has been hunted out for the most part and is now faced with extinction. Partridge (*Nothoprocta ornata*) and dove (*Zenaidura auriculata*) are reportedly rare, although doves can frequently be purchased in large numbers in the markets. California quail (*Lophortyx californica*), introduced several decades ago, are also becoming scarce in the Province. Hares and rabbits, introduced some years ago, have multiplied considerably (Péfaur, 1969, p. 6). They are hunted by the *campesinos,* especially the *comuneros,* and during the recent meat curfews in Chile, they were sold in markets of Santiago.

The ecological relations between flora and fauna in Coquimbo are little understood, and the role of extinct fauna in the evolution of the wild vegetation landscape of Coquimbo may never be interpreted. Study of that fauna and its ecological relationships to man is surely warranted.

AFFORESTATION AND REFORESTATION

Both afforestation and reforestation have been discussed in Coquimbo since the colonial period, but few hectares have been devoted to tree plantations, and the dry hillslopes have yet to be reforested with native or exotic trees. At present, no forest plantations are being seeded on either irrigated or unirrigated lands in Coquimbo, although the Corporación de Fomento de la Producción is experimenting at Corral de Julio with a number of native and exotic trees for afforestation. Only 620 hectares of trees have been planted in the Province, and 614 of these are in eucalyptus.

A large number of exotic trees are used as ornamentals in the Province, and the irrigation ditches and fields of many large *fundos* are lined with poplar and eucalyptus. Most

introduced trees on the tree plantations, however, are heavy water users and consume valuable irrigation water. Besides, most exotic trees are of no use to the *campesino* for either firewood or charcoal, and of only limited use as building materials. Most afforestation and reforestation projects have met with little success in Coquimbo and hardly merit continued effort.

5

CONTINUED ECOLOGICAL INSTABILITY OR CONSERVATION

Little, if any, of the wild plant cover of Coquimbo has escaped the transforming hand of man. Indeed, man's impact on the vegetation has been so intense that one is actually discussing a cultural landscape when speaking of the wild lands of Coquimbo. Outside of the major river valleys or other areas where the wild vegetation has been completely removed or replaced by xerophytic communities, the gross physiognomy of the wild vegetational landscape appears, for the most part, to have changed little since the sixteenth century. Only the composition and diversity of its species have changed greatly. The vegetation of the Province is more xerophytic than that described by the early Spanish chroniclers, and herbaceous weedy adventives, especially from mediterranean regions, have gained a numerical ascendency over endemics in the herbaceous cover.

From an economic point of view, the wild lands of Coquimbo are extremely fragile because of the economic and social marginality of the *campesino,* for they afford the *campesino* neither a good living nor a stable economy. As pointed out in earlier chapters, the *campesino* utilizes the land in much the same manner as did his colonial forefathers, and his basic patterns of living on the land endure, regardless of the short-lived economic changes that have affected the wild vegetation of the Province, or the degree to which the *campesino* has participated in these changes.

Within the confines of his rather archaic technological levels, the *campesino* utilizes the land in nearly every feasible way. Whether he is a small property owner or a member of a *comunidad,* he perceives and exploits his physical environment in the same manner. At best, he ekes out a bare subsistence from horticulture, agriculture, pastoralism, mining, woodcutting, charcoal burning, and wild-plant collecting. Environmental resistances are so great in some regions of Coquimbo that the *campesino*'s main economic pursuits are confined to only one or two of the above endeavors, and these are usually the only human activities that have a dominant influence on the wild vegetation.

One would think that the different systems of land tenure in Coquimbo would be easy to delimit on large-scale aerial photographs, because of differences in intensity of land use, especially between *comunidades* and *fundos.* That is not the case, however, and in most situations it is difficult to distinguish *fundos* from *comunidades* in aerial photographs on the basis of land use. The well-managed *fundos* can be clearly identified on air photos only because their boundaries are delimited by higher-density plant cover along fence lines or by

transitional zones of gradation in plant cover and density. The land resources of *fundos* are generally as marginal as those of *comunidades,* and since most *fundo* owners try to maximize their profits, *fundos* often resemble *comunidades* in intensity of land use. Besides, *fundo* owners generally have no greater technological know-how in exploiting the resources of their environment than do the *campesinos;* indeed, the owners seldom know as much about the land as the *campesinos* who work for them.

Regardless of how intensely the *campesino* utilizes the wild vegetation, he has little control over his physical environment in terms of confronting natural disasters and is usually ill-prepared to confront the periodic droughts that often totally destroy his crops and livestock. Although the *campesino* has increased the productivity of his natural environment, especially in terms of the technology available to him, his economic activities are not well-adjusted to the resistances of his physical environment or to conservation of the natural resources. Some scientists believe that the *campesino*'s way of life has endured for 400 years because he had achieved a stable adjustment between his numbers, his technology, and his physical environment. Only at a few points in time, however, has this so-called equilibrium between man and the land in Coquimbo really existed; in fact, the wild vegetation and the fertility of the land are decreasing faster than they are recovering.

Probably sometime in 1940 a stage was reached at which the land could not support any more rural inhabitants under the archaic technological levels that characterize the *campesino*'s subsistence patterns, and the rural population began to decrease in direct proportion to the decline in the natural-resource base and because too few technological innovations were forthcoming to offset the need for increased agricultural production.

The degradation of the wild lands of Coquimbo has taken place over a long period, with brief cycles of accelerated degradation related to short-lived economic changes. In the distant past, however, land was plentiful enough that the destructive impact of man was little reflected in levels of production. Since natural resources tend to recover much more slowly than the growth of man's needs for new lands and increased production, ruined lands are added annually to the vast areas of the Province that have become unproductive.

Since 1942, the date of the earliest reasonably accurate rural population census data, the number of rural inhabitants in Coquimbo has declined considerably (e.g., in 1942 there were 160,218 rural inhabitants in Coquimbo; in 1960 there were 148,843).[1] During the same period (1942-1960), the urban population of Coquimbo grew by 66,000.[2] Since 1960, the *comunas* of La Higuera, Paihuano, Samo Alto, Monte Patria, Punitaqui, Combarbalá, Illapel, and Mincha have all suffered population losses (see table 8). Only *comunas* containing cities have increased in population.

Historically, the most marginal natural resources and economies in Coquimbo have been found on the *comunidades,* which have traditionally had the most transient population; for when the rains fail, the *comuneros* usually move to the cities or go to work in the mines in order to survive. Although droughts have always led to wide population fluctuations in the rural areas of Coquimbo, the *comunidades* have suffered the greatest population decreases in the past 30 years.

The movement of people out of rural areas in the last 30 years (to mines in the north and to Chile's major cities) is no longer transitory, as when periodic droughts in the past have pushed the people out of the countryside; nor can it be attributed to the attraction of city life—the land is simply not recovering as fast as it is being degraded.

Birth control and/or vast technological changes which can reclaim degraded lands and increase agricultural production seem to be the only possible means of avoiding impending economic and social disaster for Coquimbo's agricultural population. The diffusion of vast

Table 8
Population Changes by *Comunas* in the Province of Coquimbo
1960-1970[a]

COMUNAS	POPULATION - 1960	POPULATION - 1970	PERCENTAGE DIFFERENCE
Total	309,177	336,821	8.9
La Serena	57,272	71,898	25.5
La Higuera	9,594	6,991	-27.1
Vicuña	12,068	13,806	14.4
Paihuano	6,463	6,048	- 6.4
Coquimbo	41,538	55,360	33.3
Andacollo	9,126	9,987	9.4
Ovalle	46,810	53,433	14.2
Samo Alto	7,225	5,689	-21.3
Monte Patria	19,766	18,927	- 4.2
Punitaqui	17,756	16,167	- 9.0
Combarbalá	17,966	17,332	- 3.5
Illapel	21,675	20,660	- 4.7
Salamanca	18,318	18,741	2.3
Los Vilos	10,033	10,453	4.2
Mincha	13,567	11,329	-16.5

[a]Chile, ODEPA, Departamento Programación Grupo Estadística, "Población del país y por provincias a nivel comunal según censos de 1970 y 1960" (Santiago, 1971), p. 3. (Mimeographed.)

technological changes into the extremely conservative culture of the *campesino*, however, seems difficult, if not impossible.

NATURAL REGIONS AND LAND USE

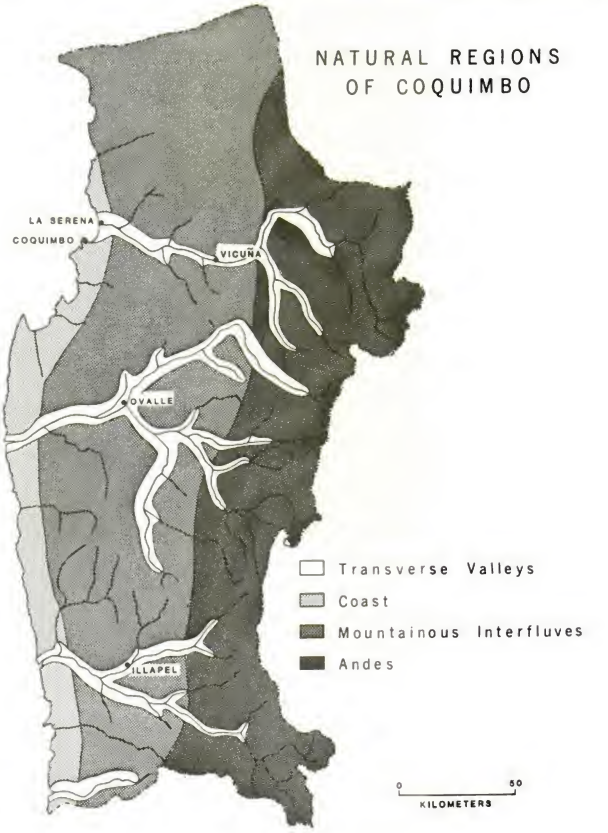
To gain an appreciation and understanding of vegetation change in Coquimbo and of the major human activities that have effected those changes, the Province can be divided into four landscape types roughly corresponding to the vegetation regions described in Chapter II (see map 5). Each type will be briefly described, and the activities of man will be pointed out which appear to have had the greatest impact on the present structure and composition of the wild plant cover.

Type I. The Transverse Valleys and Their Tributaries

The river valleys of Coquimbo support an almost completely exotic vegetation. They were the first areas of concentrated settlement in the Province and have borne the brunt of human settlement. Except for some dry farming along the coast and in the interior, all crop

1. Chile, Dirección de Estadística y Censos, *Algunos resultados provinciales del XIII censo de población obtenidos por muestreo* (Santiago, 1963), p. 124. These data are not trustworthy, however, because of the changing definitions of what constitutes an urban or a rural population.

2. Chile, Dirección de Estadística y Censos, *Población total por provincias, Chile: 1885-1960* (Santiago, 1964), p. 4.



Map 5. Natural regions of Coquimbo.

production in the Province is confined to the major irrigated valleys (Elqui, Limarí, Choapa, and Quilimarí) and their tributaries, where the bulk of Coquimbo's 336,000 people live. These river valleys contained the only heavily wooded areas described in the Province by the early Spanish chroniclers. Most of these riparian forests have been so decimated by woodcutting and clearing for crops, however, that the river valleys presently show little evidence of once having had extensive wooded areas. The present wild riparian vegetation consists largely of introduced trees and both exotic and endemic weeds.

Type II. The Dry Mountainous Interfluves

The dry uplands and interfluves of the interior support a type of cactus-scrub plant cover. This vegetation reflects increased precipitation as one moves from north to south in the Province, changing to a dense *monte* of woody shrubs and low scattered sclerophyllous trees in the southern regions. Whereas the valleys have been areas of concentrated settlement and irrigated agriculture, the dry interfluves, with their cover of cactus-scrub and *monte*, have served as areas of pasture and browse for goats, and as a source of firewood.

Since 70 per cent or more of the cooking and heating fuel consumed in Coquimbo comes from firewood and charcoal, no single activity except goat-grazing has had a more devastating impact on the vegetation cover of the interior than the long history of continuous woodcutting. Goats are well equipped to utilize the thorny browse of the interfluves, and most of the goats in the province occupy that landscape type. Collection of a wide variety of wild plant products for commercial purposes has led to the near-extinction of some species.

A rank order of the human activities which have had the greatest effect on the wild vegetation of the interior is: woodcutting, pasturing of goats, dry farming, and commercial gathering of wild plant products. In terms of income generated, the major economic activity of Coquimbo is mining, and miners have traditionally played a profound role in altering the plant cover of the dry interfluves. The interfluves are covered with mine shafts, most of which follow rather shallow veins, and large areas of degraded vegetation often indicate active or abandoned mining sites. Aside from miners, there are other *campesinos* living in the mountains, herding goats to produce cheese or cutting firewood and making charcoal to sell in the valleys. Indeed, no part of the interior seems to be without man's influence, and much of this region's wild vegetational cover has been badly degraded.

Type III. The Coast

Because of the high incidence of cloudiness, constant fog, and dew, vegetation is more luxuriant along the coast than in any part of the Province outside of the river valleys. From the northern borders of Coquimbo to the mouth of the Río Limarí is a region of dense cactus-scrub. This region, however, has a land-use history similar to that of the interior of Coquimbo. South of La Serena some dry farming occurs, but farming by *lluvias* along the coast does not generally become a regular activity until one nears Tongoy. Dominant activities from Tongoy to the southern boundary of Coquimbo are dry farming and the raising of sheep, the latter usually on large estates.

As one moves south of the Río Limarí along the coast the vegetation becomes denser, and more mesophytes appear. Shrub size increases and the annual cover remains longer on the ground. Large sections of the coast, from the Río Limarí to Pichidangui, are cleared for dry farming or have been cleared in the past; in fact, aerial photographs indicate that 30 per cent or more of the coastal terraces and seaward-facing slopes of the coast ranges have been

cleared at one time or another for *lluvias*. The yields are so meager that the farmers barely break even in most years. Soil conservation is ignored, and abandoned fields, left to goats and sheep, soon become gullied and eroded. Between Caleta Oscuro and Bahía Teniente, the vegetation takes on the appearance of the coastal scrub and chaparral communities found in the coastal ranges of California. The coastal areas have been heavily affected by the activities of man; and, except in the major river valleys, the coastal and interior portions of Coquimbo show the greatest degree of man-induced changes in the wild plant cover. Along some areas of the coast, shrubs are encountered only around stacks, in *quebradas*, or in other areas too difficult to clear for farming, and even those areas are heavily browsed and cut for firewood.

Cloud or fog forests occur on the seaward-facing summits of the coast ranges at elevations above 460 meters. Two such forests—Fray Jorge and Talinay, surrounded by communities dominated by xerophytic shrubs—contain species similar to those found in the humid temperate forests of southern Chile. *Campesinos* frequently state that cloud forests, similar to those at Fray Jorge and Talinay, once occupied the high summits of the coast ranges near Peña Blanca, Caleta Oscuro, and Huentelauquén but were cut out many years ago. Cloud forests having some species similar to those encountered at Fray Jorge have been noted at Agua Amarilla and on the peaks southeast of Pichidangui.

Type IV. The Andes

Structurally, the vegetation on the lower slopes of the Andes is quite similar to that described for the interior of Coquimbo, though it tends to be closer to the ground and more xerophytic. Shrubby thickets are encountered occasionally on the dry slopes, but trees and dense vegetation are usually confined to sheltered places or to areas having high soil moisture. As altitudes increase, woody shrubs and cacti decrease until, at very high elevations, only herbs and some scattered pillowlike or cushionlike plants are encountered. The upper limits of the vegetation in Coquimbo are at 4200 meters in the north and 3800 meters in the south. Where the water supply at high elevations is constant, however, such as around lagoons or in marshes (*vegas*), a dense ground cover of sedges and grasses occurs, forming pastures of great economic importance for transhumance during the summer. Woodcutting and pastoralism have been major activities affecting the wild vegetation of the high Andes. In many areas the *vegas* have suffered from overuse and trampling. In general, however, this is the least degraded region in Coquimbo, appearing to have undergone minimal vegetation change.

A FUTURE OF FURTHER IMPOVERISHMENT?

In general, *campesinos* are unaware that their economic activities are destructive of the land, and few see their land as being degraded. Lower productivity is therefore blamed by most on the droughts or on the "advancing desert." They believe that just a little more rain will make the land productive once again. The concept of the "advancing desert," however, implies misuse of the land. Those *campesinos* who do recognize the destructive effects of their land-use patterns are so trapped by the marginality of their technological and physical environment that they can ill afford to change their systems of land use.

In many ways the *campesino* obtains greater economic returns from the chaparral and desert-scrub communities of Coquimbo than are obtained from similar communities in California. Few people in California, however, depend directly on the state's chaparral and desert-scrub communities for their livelihood. The chaparral supplies California with valuable watershed protection, grazing lands, and recreational areas; but to the average Californian

the chaparral means little more than a fire hazard–and, indeed, there is a tremendous waste of energy every year in California when thousands of acres of chaparral are destroyed by fire. Brush-conversion programs of unknown ecological impact are under way in parts of California to convert chaparral into grassland for cattle, ignoring the goat, a great energy converter of chaparral phytomass.

The major economic and social problems confronting Coquimbo seem to lie in implementing a program of wild-resource management which will not only maximize production from the meager agricultural resources of the Province but protect the wild lands from further degradation. Since less than 2.5 per cent of the Province is irrigated, and the remainder of the land is considered unarable or marginally productive, government agricultural planners have not been much concerned with managing the wild lands of Coquimbo. Moreover, Chile is presently plagued by too many political and economic problems, some a result of abuse of the land, to be very concerned with conservation measures in such a marginal agricultural area as Coquimbo. In any case, none of Chile's major agricultural areas practice much conservation. Unless measures are soon taken to arrest the degradation of the wild lands of Coquimbo, however, the consequent problems of underemployment, starvation, and mass movements of rural peoples to the cities will affect the political and economic stability of the region.

The numerous conservation laws promulgated in Coquimbo since the colonial period have been persistently violated and poorly enforced. The basic problem in bringing about conservation and land-use change in Coquimbo is not so much legal or technical as cultural. Few planners have taken into consideration the inertia in the *campesino*'s way of living on the land, much less attempted to understand his culture. Without understanding of the *campesino's* land-use activities and his culture, most planned economic and social changes in the agricultural sector of Coquimbo's economy are doomed to failure. The *campesino*'s subsistence patterns are simply not geared to a system of sustained yields, and he is ill-equipped to carry out conservation programs that cut his yearly production or require much capital expenditure. Also curtailing economic and community-development programs in the Province are the lack of capital and trained technicians.

At present, there are no government-sponsored conservation programs in Coquimbo, nor is there any type of wildlands management. Although there is little public land in the Province, the government could institute a system of wildlands management on expropriated *fundos* or *comunidades.*

The future of Coquimbo's wild vegetation and wildlands seems rather bleak in the face of the continued environmental degradations by man. There is an incomplete knowledge, if not an indifference, to the changes which man has triggered in the ecosystems of Coquimbo. There are few ecological studies of the Province, and no studies which pay attention to cultural and natural history in the evolution of the present plant cover of Coquimbo. Only one small private organization (Eco-Equilibrio y Conciencia) seems to be paying more than lip service to the profound ecological problems confronting Chile, and to the consequences that man's mismanagement of the wild vegetation will have on future generations of Chileans.

This investigation does not intend to predict a future of environmental impoverishment for Coquimbo, nor to propose solutions to existing ecological problems. It seeks only to emphasize the role of culture history and cultural ecology in understanding the evolution of the wild vegetation of the Province, and to point out that future economic and community development programs in Coquimbo cannot work unless conservationists, economic planners, ecologists, agronomists, and others understand the *campesino*'s culture, his perceptions of the land, and his land-use activities.

6

EPILOGUE

The wild landscape and the *campesinos*' economic condition continue to deteriorate despite a number of land-use and economic-development programs that were initiated when the Chilean government declared Coquimbo a "zone of extreme poverty." The rural lands support fewer people than ever before, and *campesinos* are emigrating to the cities in increasing numbers. Yet land-use planners in Santiago speak of the productivity of the Province's natural ecosystems as all declining, whereas many of these ecosystems never yielded more to man than they do at present. The planners seem not to realize that frequent droughts and a limited irrigation surplus condemn Coquimbo to being irredeemably marginal as an agricultural region.

The Instituto de Investigaciones Agropecuarias (INIA), with financial and advisory aid from FAO and WMO, recently completed the most comprehensive report ever done on the problem of desertification in the Province—"Case Study on Desertification: Region of Combarbalá"—which was published by the United Nations Conference on Desertification (1977). Appendix C reproduces that report's single page of recommendations for coping with desertification and its consequences in the Combarbalá region. It included no plan for implementing its recommendations.

Many previous rural land-use programs, some sponsored by Unesco and UNDP, have failed because, like the present programs, their design neglected to include a realistic appraisal of the *campesino*'s perception and use of the land or of his resistance to change. Moreover, few planners and technical advisors appreciate the ingenuity and efficiency with which the *campesino* uses the resources of his physical environment. Unless these factors are understood and included in a program design, planners will fail to bring about the radical changes needed in management of the Province's rural lands.

For the most part, the short-term success of rural nonmining development schemes in Coquimbo has been contingent on continuing outside financial support and technical assistance; and when that sponsorship ended, so did the programs. In general, the *campesino*'s subsistence is so marginal that he dare not adopt any program that does not promise immediate rewards. Further, no program can conflict greatly with his traditional lifestyle. For the most part, he will accept only land-use changes which are economically viable alternatives to his traditional systems.

I cannot help but be somewhat fatalistic about the future of Coquimbo's wild lands and rural inhabitants. No development program, either Chilean or UN-sponsored, has been able to overcome the inertia in the traditional systems of land use in the Province, let alone attempted to understand the *campesino* and his land-use patterns. This book aims at presenting the land-use planner with a different perspective on the problem of man's misuse of the natural vegetal and soil resources of the Province. The misuse of the land must be halted soon if the *campesino* and his way of life are to be rescued from a bleak future.

Appendix A

PRINCIPAL WILD VASCULAR PLANTS OF COQUIMBO PROVINCE*

Adiantaceae
Adiantum excisum Kunze
A. weatherbyanum Espinosa
Aextoxicaceae
Aextoxicon punctatum R. & P.
Agavaceae
Agave americana L.
Aïzoaceae
Carpobrotus chilensis (Mol.) N.E. Brown=
Mesembryanthemum chilensis Mol.
**M. crystallinum* L.
Alliaceae
Ancrumia cuspidata Harv.
Brodiaea guadichaudiana (Kunth) Fuentes
Leucocoryne purpurea Gay
Alstroemeriaceae
Alstroemeria gayana Phil.
A. sierrai Muñoz
A. violacea Phil.
Amaranthaceae
Amaranthus sp.
**A. deflexus* L.
**A. hybridus* L.
Amaryllidaceae
Hippeastrum spp.
H. bicolor (R. & P.) Baker
Placea amoena Phil.
Anacardiaceae
Lithraea caustica (Mol.) H. & A.
Schinus dependens Engl.
S. latifolius (Gill.) Engl.
S. molle (L.) DC.
S. montanus Engl.
S. polygamus (Cav.) Cabrera
Apocynaceae
Elytropus chilensis Muell.–Arg.
Aristolochiaceae
Aristolochia chilensis Bridges ex Lindl.
A. pearcei Phil.
Asclepiadaceae
Astephanus geminiflorus Dcne.
Cynanchum boerhavifolium H. & A.
Diplolepis menziesii R. & S.
Tweedia confertiflora (Dcne.) Malme
Aspidiaceae
Dryopteris spectabilis (Kaulf.) Macl.
Polystichum adiantiforme (Forst.) J. Sm.
Aspleniaceae
Asplenium dareoides Desv.

Berberidaceae
Berberis brachybodria Gay
B. coquimbensis Muñoz
B. empetrifolia Lam.
B. glomerata H. & A.
Bignoniaceae
Argylia puberula DC.
A. radiata (L.) D. Don
Blechnaceae
Blechnum auriculatum Cav.
B. chilensis (Kaulf.) Mett.
Boraginaceae
Amsinckia hispida (R. & P.) Johnst.
**Borago officinalis* L.
Cryptantha spp.
Heliotropium floridum H. & A.
H. stenophyllum H. & A.
Pectocarya spp.

*Exotic species are indicated by double-asterisks.

Bromeliaceae
Puya alpestris (Poepp.) Gay
P. chilensis Mol.
P. venusta Phil.
Buddlejaceae
Buddleja gayana Benth. in DC.
B. globosa Lam.

Cactaceae
Copiapoa sp.
Echinocactus ceratistes Otto ex Pfeiff.
Eriosyce ceratistes (Otto) B. & R.
Eulychnia acida Phil.
E. breviflora Phil.
E. castanea Phil.
E. spinibarbis (Otto) B. & R.
Neoporteria subgibbosa (Haworth) Britt. & Rose
Opuntia miquelii Monville
O. ovata Pfeiff.
Trichocereus sp.
T. chiloensis Brit. & Rose
T. coquimbensis Mol.
T. nigripilis Phil.
T. skottsbergii Back.
Callitrichaceae
****Callitriche autumnalis* L.
Calyceraceae
Boöpis sp.
B. agglomerata (Miers) Hauman
Campanulaceae
Cyphocarpus rigesciens Miers
Hypsela spp.
Lobelia polyphylla H. & A.
L. salicifolia Sweet
Caricaceae
Carica chilensis Solms-Laub.
Caryophyllaceae
****Cardionema ramosissimum* (Weinm.) Nels. & Macbr.
****Cerastium arvense* L.
Corrigiola latifolia Gay
C. squamosa H. & A.
Paronychia chilensis DC.
****Silene gallica* L.
Spergularia spp.
S. arbuscula (Gay) Johnst.
****S. media* (L.) Presl.
Stellaria cuspidata Willd.
****S. media* (L.) Vill.
Celastraceae
Maytenus boaria Mol.
Chenopodiaceae
Atriplex spp.
A. coquimbensis Muñoz
A. repanda Phil.
****A. semibaccata* R. Br.
****Chenopodium album* L.
****C. ambrosioides* L.
****C. murale* L.
C. paniculatum Hook.
Salicornia peruviana HBK.
****Salsola kali* L.
Compositae
****Anthemis cotula* L.
Baccharis concava Pers.
B. confertifolia Colla
B. linearis (R. & P.) Pers.
B. paniculata DC.
B. pingraea DC.
B. racemosa DC.
B. rosmarinifolia H. & A.
B. sagittalis DC.
B. tola Phil.
B. volckmanii Phil.
Bahia ambrosioides Lag.
****Bidens pilosa* L.
****Carduus pycnocephalus* L.
Centaurea sp.
C. chilensis H. & A.
Chaetanthera sp.
Chrysanthemum sp.
Chuquiraga oppositifolia Don
C. spinosa (R. & P.) D. Don
C. ulicina H. & A.
****Cichorium intybus* L.
****Cirsium lanceolatum* (L.) Scop.
****C. vulgare* (Savi) Ten.
****Cotula coronopifolia* L.
****Cynara cardunculus* L.
Encelia canescens Walp.
E. oblongifolia DC.
E. tomentosa Walp.
Erigeron berterianus DC.
Eupatorium glechonophyllum Less.
E. salvia Colla
Facelis spp.
Flourensia gayana Remy
F. thurifera (Mol.) DC.
Gnaphalium spp.
****G. chilensis* Spreng.
****G. purpureum* L.
Gochnatia litoralis Phil.
Gutierrezia gayana Remy
G. paniculata DC.
Haplopappus spp.
H. baylahuen Remy
H. foliosus DC.
H. glutinosus DC.
H. latifolius (Phil.) Reiche
H. muconatus H. & A.
****Helenium aromaticum* (Hook.) Bailey
Hypochoeris scorzonerae F. Muell
****Madia sativa* Mol.
Moscharia pinnatifida R. & P.
Mutisia acerosa Poepp. ex Less.

M. reticulata Phil.
M. spectabilis Phil.
Nardophyllum sp.
N. lanatum (Meyen) Cabr.
Ophryosporus foliosus (DC.) Reiche
O. triangularis Meyen
Perezia spp.
Pleocarphus revolutus D. Don
Podanthus mitiqui Lindl. in Loud.
Polyachyrus spp.
P. foliosus Phil.
Proustia baccharoides Don ex H. & A.
P. cinerea Phil.
P. pungens Poepp. ex Less.
P. pyrifolia Lag.
P. reticulata Phil.
Senecio spp.
S. benaventianus Remy
S. eriophyton Remy
S. fistulosus Poepp. ex Less.
S. murorum Remy
***S. vulgaris* L.
S. yegua (Colla) Cabr.
***Silybum marianum* (L.) Gaertn.
***Soliva sessilis* R. & P.
***Sonchus asper* (L.) Hill
***S. oleraceus* L.
Spilanthes sp.
***Taraxacum officinale* Weber ex Wigg.
Tessaria absinthioides (H. & A.) DC.
Triptilion sp.
***Urospermum picroides* F.W. Schmidt
Werneria spp.
***Xanthium spinosum* L.

Convolvulaceae
Calystegia sp.
***Convolvulus arvensis* L.
***Dichondra repens* Forst.

Cornaceae
Griselinia scandens (R. & P.) Taub.

Crassulaceae
Crassula sp.

Cruciferae
***Brassica campestris* L.
***B. nigra* (L.) Koch
***Capsella bursa-pastoris* (L.) Medik.
Cardamine nasturtioides Bert.
Descurainia sp.
Lepidium sp.
***Nasturtium officinale* R. Br.
***Raphanus sativus* L.
***Rapistrum rugosum* (L.) All.
Sisymbrium spp.

Cucurbitaceae
Sicyos bryonifolia Moris

Cuscutaceae
Cuscuta chilensis Ker-G.
C. racemosa var. *chiliana* Engelm.

Cyperaceae
Carex spp.
***Cyperus eragrostis* Lam.
Eleocharis spp.
E. albibracteata Nees & Mey. ex Kunth
***E. pachycarpa* Desv.
***E. radicans* (Poir.) Kunth
Scirpus spp.
***S. californicus* (C.A. Mey.) Steud.
***S. cernuus* Vahl.
Uncinia phleoides (Cav.) Pers.

Dioscoreaceae
Dioscorea spp.

Ehretiaceae
Cordia decandra H. & A.

Elaeocarpaceae
Aristotelia chilensis (Mol.) Stuntz
Crinodendron patagua Mol.

Ephedraceae
Ephedra andina Poepp. ex C.A. Mey.

Equisetaceae
Equisetum bogotense HBK.
E. giganteum L.

Ericaceae
Pernettya mucronata Gaud.

Escalloniaceae
Escallonia angustifolia Presl.
E. arguta Presl.
E. illinita Presl.
E. myrtoidea Bert. ex DC.
E. pulverulenta (R. & P.) Pers.
E. revoluta (R. & P.) Pers.

Euphorbiaceae
Adenopeltis colliguaya Bert.
Colliguaja dombeyana Juss.
C. integerrima Gill. & Hook.
C. odorifera Mol.
C. salicifolia Gill. & Hook.
Euphorbia spp.
***E. ovalifolia* Engelm.
***E. peplus* L.
***Ricinus communis* L.

Flacourtiaceae
Azara spp.
A. borealis F. Phil.
A. celastrina D. Don
A. petiolaris (Don) Johnst.

Frankeniaceae
Frankenia salina (Mol.) Johnst.

Fumariaceae
***Fumaria officinalis* L.

Gentianaceae
Centaurium cachanlahuen (Mol.) Rob.
Gentiana spp.

****G. prostrata* Haenke
Gentianella ottonis (Phil.) Muñoz

Geraniaceae
****Erodium botrys* (Cav.) Bertol.
****E. cicutarium* (L.) L'Her.
****E. moschatum* (L.) L'Her.
Geranium corecore Steud.

Gesneriaceae
Mitraria coccinea Cav.
Sarmienta repens R. & P.

Gramineae
Species of the following genera are found in Coquimbo:
Agrostis
Anthochloa
Arundo
Avena
Briza
Bromus
Chusquea
Cortaderia
Cynodon
Deschampsia
Deyeuxia
Disitaria
Distichlis
Festuca
Hordeum
Koeleria
Lamarckia
Lolium
Melica
Nasella
Panicum
Paspalum
Pennisetum
Phalaris
Phragmites
Piptochaetium
Poa
Polypogon
Puccinellia
Schismus
Stipa
Trisetobromus
Trisetum
Vulpia

Grossulariaceae
Ribes spp.
R. georgianum Phil.
R. punctatum R. & P.
R. trilobum Meyen

Gunneraceae
Gunnera chilensis Lam.

Haloragidaceae
Myriophyllum elatinoides Gaud.

Hydrophyllaceae
Phacelia sp.

Hymenophyllaceae
Hymenophyllum peltatum Desv.

Hypericaceae
****Hypericum perforatum* L.

Icacinaceae
Villaresia mucronata R. & P.

Iridaceae
Sisyrinchium graminifolium Lindl.
S. junceum E. Mey.

Juncaceae
Juncus spp.
****J. acutus* Engelm.
****J. bufonius* L.
Luzula spp.
Potosia spp.

Juncaginaceae
****Triglochin maritimum* L.
****T. palustris* L.

Krameriaceae
Krameria cistoidea H. & A.

Labiatae
Kurtzamra pulchella (Clos) O.K.
****Lavandula pulegium* L.
Lepechinia salviae (Lindl.) Epl.
****Marrubium vulgare* L.
****Mentha citrata* Ehrh.
****M. piperita* L.
****M. pulegium* L.
****Prunella vulgaris* L.
Satureja gilliesii (Grah.) Briq.
Stachys sp.
S. grandidentata Lindl.
Teucrium sp.
T. bicolor Sm. in Rees.

Lauraceae
Cryptocarya alba (Mol.) Looser

Ledocarpaceae
Balbisia peduncularis (Lindl.) D. Don

Leguminoseae
Acacia caven (Mol.) H. & A.
Adesmia spp.
A. aphylla Clos
A. arborea Bert.
A. bedwelli Skotts.
A. cinerea Clos
A. microphylla H. & A.
A. reclinata Muñoz
A. subterranea Clos
Astragalus limariensis Muñoz
A. ovallensis Clos
Balsamocarpon brevifolium Clos
Caesalpinia angulicaulis Clos
C. spinosa (Mol.) O. Ktse.
Calliandra chilensis Benth.
Cassia acuta Meyen

C. arnottiana Gil. & Hook.
C. closiana Phil.
C. coquimbensis Vogel
C. obtusa Clos
C. stipulacea Ait.
C. urmentae Phil.
Errazurizia multifoliolata (Clos) Johnst.
Geoffroea decorticans (Gill. ex H. & A.) Burk.
***Hoffmanseggia falcaria* Cav.
Hosackia subpinnata (Lag.) T. & G.
Lathyrus spp.
L. berterianus Colla
L. hookeri G. Don
L. pubescens H. & A.
Lupinus microcarpus Sims.
***Medicago arabica* (L.) Huds.
***M. hispida* Gaertn.
***M. sativa* L.
***Melilotus indicus* (L.) All.
Prosopis chilensis (Mol.) Stuntz
Psoralea glandulosa L.
***Trifolium* spp.
***T. pratense* L.
***T. repens* L.
***Vicia sativa* L.

Liliaceae
Bottionea plumosum (R. & P.) MacBride
Fortunatia biflora (R. & P.) MacBride
Pasithea caerulea (R. & P.) D. Don

Linaceae
Linum chamissonis Schiede
L. macraei Benth.

Loasaceae
Loasa spp.
L. tricolor Ker-G.

Loranthaceae
Phrygilanthus aphyllus (Miers) Eichl.
P. sternbergianus Roem. & Sch.
P. tetrandus (R. & P.) Eichl.
Psittacanthus cuneifolius (R. & P.) G. Don

Lythraceae
***Lythrum hyssopifolia* L.
Pleurophora sp.

Malesherbiaceae
Malesherbia sp.

Malpighiaceae
Dinemagonum maculigerum Phil.
Dinemandra sp.

Malvaceae
Cristaria spp.
Malva spp.
***M. parviflora* L.
Sphaeralcea obtusiloba (Hook.) G. Don

Monimiaceae
Peumus boldus Mol.

Myrtaceae
Myrceugenella chequen (Mol.) Kaus.
M. correaefolia (H. & A.) Berg
Myrceugenia ferruginea (H. & A.) Reiche
Reicheia coquimbensis (Barn.) Kaus.

Nolanaceae
Alona spp.
A. rostrata Lindl.
Nolana sp.
N. paradoxa Lindl.

Nyctaginaceae
***Mirabilis jalapa* L.

Onagraceae
Clarkia sp.
***C. tenella* (Cav.) Lewis & Lewis
Epilobium sp.
Fuchsia lycioides Andr.
Oenothera spp.
***O. contorta* Dougl. ex Hook.

Orchidaceae
Bipinnula sp.
Chloraea spp.
C. ulanthoides Lindl.

Oxalidaceae
Oxalis spp.
O. gigantea Barn.
O. peraltae Phil.
O. rosea Jacq.

Palmae
Jubaea chilensis (Mol.) Baillon

Papaveraceae
***Argemone mexicana* L.
***Eschscholzia californica* Cham.
***Papaver somniferum* L.

Peperomiaceae
Peperomia coquimbensis Skottsb.
P. fernandeziana Miq.
P. nummularioides Griseb.

Phytolaccaceae
Anisomeria litoralis (Poepp. & Endl.) Moq.
Ercilla spicata (Bert.) Moq.

Plantaginaceae
Plantago spp.
***P. hirtella* HBK.
***P. hispidula* R. & P.
***P. lanceolata* L.
P. litorea Phil.
***P. major* L.
P. patagonica Greene
***P. virginica* L.

Plumbaginaceae
Limonium sp.
Plumbago coerula H.B. Kth.

Polemoniaceae
Gilia sp.

Polygalaceae sp.
Monnina sp.

Polygonaceae

****Chorizanthe ramosissima** Benth.
Muehlenbeckia hastulata (J. Sm.) Standl. ex Macbr.
Polygonum sp.
Rumex spp.
****R. crispus** L.

Polypodiaceae
Hypolepsis punctata (Thunb.) Mett.
Polypodium feuillei Bertero

Portulacaceae
Calandrinia spp.
C. aurea Barn.
C. crassifolia Phil.
C. discolor Schrad.

Primulaceae
****Anagallis arvensis** L.

Rafflesiaceae
Pilostyles berteroi Guill.

Ranunculaceae
Anemone decapetala L.
Barneoudia chilensis Gay
Caltha andicola Gay
****Ranunculus muricatus** L.

Rhamnaceae
Colletia sp.
C. spinosa Lam., emend. Suess
Discaria prostrata Miers
D. trinervis Miers
Retanilla ephedra (Vent.) Brongn.
Talguenea quinquenervia (Gill. & Hook.) Johnst.
Trevoa trinervis Miers

Rosaceae
Acaena spp.
A. argentea R. & P.
A. laevigata Ait.
A. ovalifolia R. & P.
A. pinnatifida R. & P.
Kageneckia angustifolia D. Don
K. oblonga R. & P.
Margyricarpus pinnatus Lam.
Quillaja saponaria Mol.
****Rubus ulmifolius** Schott
Tetraglochin sp.
T. alatum (Gill. ex Hook.) O. Ktze.

Rubiaceae
Cruckshanksia sp.
C. hymenodon H. & A.
C. pumila Clos
Galium spp.
****G. aparine** L.
Nertera depressa Banks & Soland.
N. granadensis (Mutis ex L.f.) Drude
Relbunium hypocarpium (L.) Hemsl.
****Viviana crenata** (Hook.) G. Don ex H. & A.
****V. rosea** (Hook.) Klotzsch

Rutaceae
Ruta bracteosa DC.
****R. graveolens** L.

Salicaceae
Salix chilensis Mol.
S. humboldtiana Willd.

Santalaceae
Arjona andina Phil.
Myoschilos oblonga R. & P.
Quinchamalium sp.

Sapindaceae
Bridgesia incisaefolia Bert.
Dodonaea viscosa L.
Llagunoa glandulosa (H. & A.) Walp.
Valenzuelia trinervis Bert.

Sapotaceae
Lucuma valparadisea (Mol.) A. DC.

Scrophulariaceae
Alonsoa incisifolia R. & P.
Calceolaria spp.
C. arachnoidea Grah.
C. corymbosa R. & P.
C. georgiana Phil.
C. picta Phil.
Mimulus sp.
****M. luteus** L.
Monttea chilensis Gay
Ourisia sp.
Stemodia chilensis Benth. in DC.
****Verbascum virgatum** Stokes in With.

Sinopteridaceae
Notholaena mollis Kunze

Solanaceae
Cestrum parqui L'Her.
****Datura stramonium** L.
Dunalia lycioides Miers
Fabiana barriosii Phil.
F. imbricata R. & P.
Lycium sp.
L. chilense Bert.
****Nicotiana acuminata** (Grah.) Hook.
****N. glauca** Grah.
Phrodus bridgesii Miers
Salpiglossis spinescens Clos
Schizanthus sp.
S. litoralis Phil.
S. pinnatus R. & P.
****Solanum crispum** R. & P.
****S. elaeagnifolium** Gay
S. maglia Schltd.
****S. nigrum** L.
S. pinnatum Cav.
S. tomatillo Remy
Trechonaetes sp.

Tamaricaceae
****Tamarix gallica** L.

Tecophilaeaceae
Tecophilaea violiflora Bert. ex Colla
Tetragoniaceae
Tetragonia espinosae Muñoz
T. macrocarpa Phil.
Tropaeolaceae
Tropaeolum azureum Miers ex Colla
T. brachyceras H. & A.
T. hookerianum Barn.
T. tricolor Sweet
Typhaceae
***Typha augustifolia* L.

Umbelliferae
Apium panul (DC.) Reiche
Asteriscium chilense Ch. & Shl.
Azorella spp.
A. madreporica Clos
Bowlesia sp.
***Conium maculatum* L.
***Daucus carota* L.
Eryngium depressum H. & A.
E. paniculatum Cav.
***Foeniculum vulgare* Mill.
Gymnophyton polycephalum Clos
G. robustum Clos
Laretia acaulis Hook.
Mulinum spinosum (Cav.) Pers.
Myrrhis sp.
***Sanicula crassicaulis* Poepp.
***S. graveolens* DC.

Urticaceae
Urtica magellanica Poir.
***U. ureus* L.

Valerianaceae
Valerianella spp.
Verbenaceae
Acantholippia sp.
Aloysia salviaefolia (H. & A.) Moldenke
Diostea sp.
D. juncea (Gill. & Hook.) Miers
Glandularia sulphurea (D. Don) Schnack & Covas
Phyla nodiflora (L.) Greene
Rhaphithamnus spinosus (A. Juss.) Moldenke
Thryothamnus junciformis Phil.
Verbena spp.
***V. litoralis* HBK.
Violaceae
***Viola odorata* L.
Vitidaceae
Cissus striata R. & P.

Winteraceae
Drimys winteri Forst.

Zygophyllaceae
Bulnesia chilensis Gay
Fagonia chilensis H. & A.
Larrea nitida Cav.
Pintoa chilensis Gay
Porlieria chilensis Johnst.

Appendix B

LEY DE BOSQUES: REGULATIONS FOR THE EXPLOITATION OF *QUILLAY* AND OTHER FOREST SPECIES

(Decree No. 366–February 17, 1944)

Article 1. Those areas which are not irrigated or appropriate for agriculture in the immediate future, located between the northern limit of the Province of Tarapacá and the Maipo River, will be considered as forested areas for the purpose of exploitation of lumber, firewood, and charcoal.

Article 2. In the indicated region the following activities are prohibited indefinitely:

a) The uprooting of the following species: *tamarugo, algarrobo, chañar, guayacán, olivillo, carbón* or *carbonillo, espino, boldo, maitén, litre,* and *bollén.*

The cutting or exploitation of these trees or bushes will only be permitted during the months of April, May, June, and July. Except for the cutting and exploitation of "*Boldo* Leaves" which can be done only between the months of December and March of each year in the distributional area of this species in the Republic.*

b) Free exploitation of *tamarugos, algarrobos,* and *chañares* within the periods indicated in the previous clause requires written permission from the Governor or *Intendente.*

In order to obtain this permission one should solicit in writing the aforementioned authority, indicating in the solicitation whether he or she is the owner or renter of the property, the density of the forest, location and number of trees that are going to be exploited, the product that will be obtained from them, and any other data necessary in order to be granted permission.

Said solicitation shall be accompanied by a sketch of the land on which the exploitation is going to take place, relating its location to the nearest town or *estación.*

c) The exploitation of *tamarugos, algarrobos,* and *chañares* which grow on fiscal lands.

Article 3. In accordance with Article 19 of the *Ley de Bosques,* already in force, the cutting of *quillay* and the exploitation of its products, such as wood, charcoal, and bark are prohibited between January 1 and April 30 of each year. Anyone interested in exploiting this tree outside of this period shall solicit permission from the Departamento Forestal, Ministerio de Agricultura.**

Article 4. From the date of publication of this law, removing the bark from the *quillay* while the tree is standing is prohibited. Upon felling it, the cut should be *bisel* at a height which fluctuates from 20 to 50 centimeters above the ground without damaging the bark that remains on the trunk.

Article 5. Those persons who wish to incorporate land into cultivation on which *quillay* grow, shall solicit permission from the Departamento Forestal, of the Ministerio de Agricultura, and this permission will be granted only if the crop to be cultivated might give a superior yield to that which could be obtained from the exploitation of said trees.

Article 6. In areas of dry farming and in irrigated areas with steep slopes, the uprooting of *quillay* without written authorization from the Dirección de Agricultura y Pesca is not permitted.

*Modification made by D.S. No. 251 on January 31, 1955, by the Ministerio de Tierras y Colonización.

**Modification made by Decree No. 2250 on December 2, by the Ministerio de Tierras y Colonización.

Article 7. For the purposes of the application of Article 6, not only seedlings but also those trees that have stumpsprouted and are on forest land will be considered forest plantations, unless otherwise reclassified by the Servicios Técnicos del Ministerio de Agricultura.

Article 8. Infractions of the previous articles will be sanctioned by the penalties established in Articles 21, 22, and 23 of the *Ley de Bosques.*

Article 9. Those products which are illegally obtained as stated under the present regulation will be confiscated in accordance to that which has been decreed in Articles 449 and 501 of the Penal Code.

Article 10. The vigilance and carrying out of the orders of the present law correspond to the functionaries of the Ministerio de Tierras y Colonización, Agricultura, and the Carbineros de Chile.

Article 11. The buyers of "*Quillay* Bark" shall solicit authorization from the Departamento Forestal, Dirección de Agricultura y Pesca, to export this product; authorization will be granted provided that the *quillay* which is to be exported has been exploited in agreement with the dispositions of this law.

Article 12. Abolishes Decrees No. 5167 of December 29, 1933, and No. 3224 of December 16, 1938.

Registered and Published in the Official Diary.
(Fdo.) J. A. RIOS M.A. Quintana Burgos.

Appendix C

RECOMMENDATIONS FOR COPING WITH THE PROBLEMS OF DESERTIFICATION IN THE COMBARBALA REGION

Among the short-term measures, the following can be considered:

1. To develop and diversify regional mining, thus furnishing stable employment to a larger proportion of the active population.
2. To develop intensive agriculture in small irrigated valleys and ravines, which may be specifically oriented toward fruit and horticultural production and marketing.
3. To support good levels of research and exchange in agricultural and breeding activities. At present there exists a good supportive framework in the Regional Programme for Arid Zones (UNDP, World Bank, Israel).
4. To develop craftsmanship and local industries of secondary importance. The resulting resettlement of people in communities will facilitate educational activities.
5. To furnish opportunities for young people to realize their aspirations to do work other than that connected with agriculture and breeding.

Among the long-term aims the following must be considered:

1. Reorganization of the land ownership system, suppressing the excessive partition of land by assembling the minimal subsistency units into greater units.
2. To facilitate the regeneration of ecosystems in these greater units through a prolonged exclusion of cultivation and grazing in the most vulnerable areas where erosion is more intense.
3. To submit natural meadows to controlled grazing, preventing the excessive concentration of animals and regulating the resting period, to allow for the preservation and improvement of vegetation.
4. To consider preservation and improvement of natural vegetation as being of utmost priority. In specific cases, where some additional aims are possible, the regeneration of meadows could be advisable. Under present conditions it is impossible to increase on a short-term basis the animal and agricultural production to economically profitable levels.
5. Every programme or strategy selected for resolving the problems of this region must be approached in an integrated way, keeping in mind a clear differentiation between the social and even political problems of the population and those related to production efficiency.

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